MACHINERY.

Vol. 7. March, 1901. No. 7.

AMONG THE SHOPS.

NOTES TAKEN AT THE WORKS OF THE NEWPORT NEWS SHIPBUILDING AND DRYDOCK CO., NEWPORT NEWS, VA.

One of the important industries of the New South is that of shipbuilding as carried on at the plant of the Newport News Shipbuilding & Drydock Company, at Newport News, Va. The port of Newport News is situated at the head of the magnificent harbor of Hampton Roads and the mouth of the James river, the former accommodating ocean-going vessels of maximum draft and the latter giving inland water communication to Richmond. The railroad facilities afforded by the Chesapeake & Ohio also help to make the location almost unrivalled in the United States for shipping and shipbuilding. The climatic conditions are an important factor favoring the latter industry, since the winters are usually so mild that work on vessels on the ways can be continued practically throughout the year without serious interruption from inclement weather. The necessity for expensive covered shipbuilding ways is, therefore, not felt as it is in more Northern and severe climates.

The company were organized in 1888 and in March, 1892, launched their first vessel built for the Morgan line, El Sud, afterward sold to the United States government and renamed the Yosemite. Since that time the business has continually increased so that now with the work in sight which will be begun during the present year, there will be over $24,000,000 worth of work in progress for the navy and private concerns.

The shipbuilding yard has a frontage on the harbor, where the launching facilities are of the best, of nearly a mile and it covers an area of about 150 acres. At present 6,500 men are employed and with the inception of the new government work recently awarded, the number will probably be materially increased. The vessels now building are: U. S. battleship Illinois, nearly completed, 11,525 tons, $2,595,000; U. S. battleship Missouri, 25 per cent. completed, 12,500 tons, $2,885,000; U. S. monitor Arkansas, launched, 3,250 tons, $960,000; Pacific Mail line, Siberia, on ways, 18,500 tons, $2,000,000; Pacific Mail line, Korea, on ways, 18,500 tons, $2,000,000; Morgan line, El Siglo (Century), on ways, 6,000 tons, $600,000; Morgan line, El Libre (Free), on ways, 6,000 tons, $600,000;

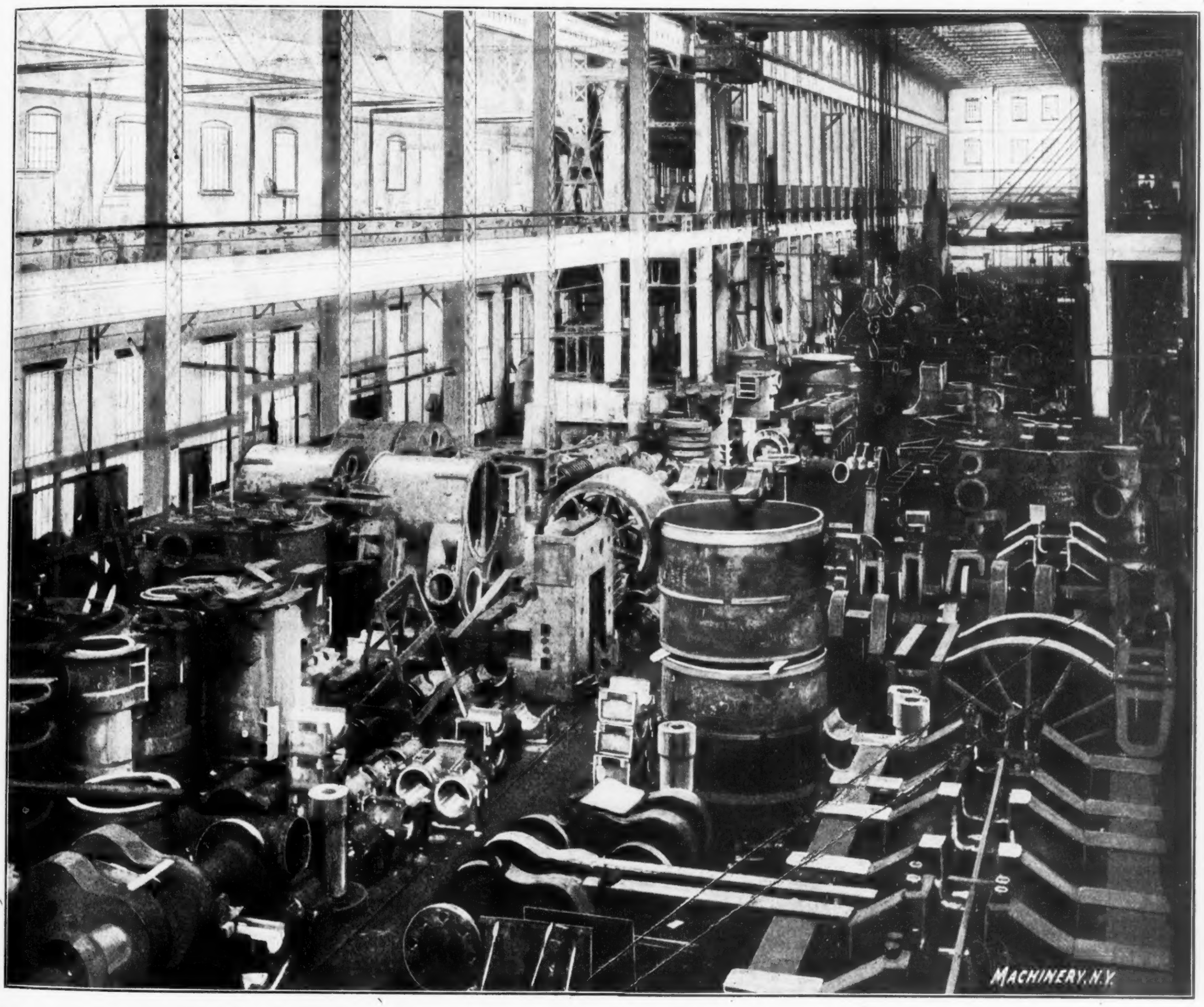


Fig. 1. Main Machine Shop, 101 feet wide by 500 feet long. Two traveling cranes, having 52 feet clearance under the hooks. Engine bed-plate for Pacific Mail steamer in foreground.

Morgan line, El Alba (Day), on ways, 6,000 tons, $600,000. The total displacement actually under construction is nearly 70,000 tons and that to be started during 1901 will increase it to nearly 130,000 tons.

At present there are six building ways served by three electric traveling cantilever cranes. Two of the trestles are built of iron and one of wood. The reach of the cranes each side of the center of the trestle is about 90 feet, so that plates and material can be supplied to the far side of very wide vessels on the ways. At the extreme end of the lateral travel, a load of 10,000 pounds can be safely handled and at fifty feet from the center the maximum load of 30,000 pounds can be raised and carried longitudinally to the ways at the rate of about 700 feet per minute. The importance of such means for expeditiously supplying materials of construction, was recognized by this company at its beginning and its first electric cantilever cranes were installed in 1891, some time before they were adopted in other yards of this country. Two steam cantilever cranes are installed in the yard for handling plates and other material.

150-ton electric revolving derrick that is used for lifting heavy parts of machinery from the dock to vessels and also the grim weapons of the battleships.

Power in the shape of steam, compressed air and electricity is furnished from one central station. The boiler plant contains eight Scotch boilers and the engine room three vertical inverted compound MacIntosh & Seymour engines direct-connected to 600 K. W. generators besides several minor units. The air compressors are in duplicate and each is of the direct-connected duplex type. All steam, hydraulic and compressed air pipes and electric mains are laid in subways, thus doing away with all overhead construction.

The main machine shop is 500 feet long and 101 feet wide and the outside machine shop for work incident to the machinery constructed in the main shop, is 176 feet long by 50 feet wide. The main shop has two electric traveling cranes, one of forty and the other of fifty tons capacity. The extreme height from the hooks to the floor is about 52 feet, a height which is none too much when erecting modern marine engines with tandem cylinders.

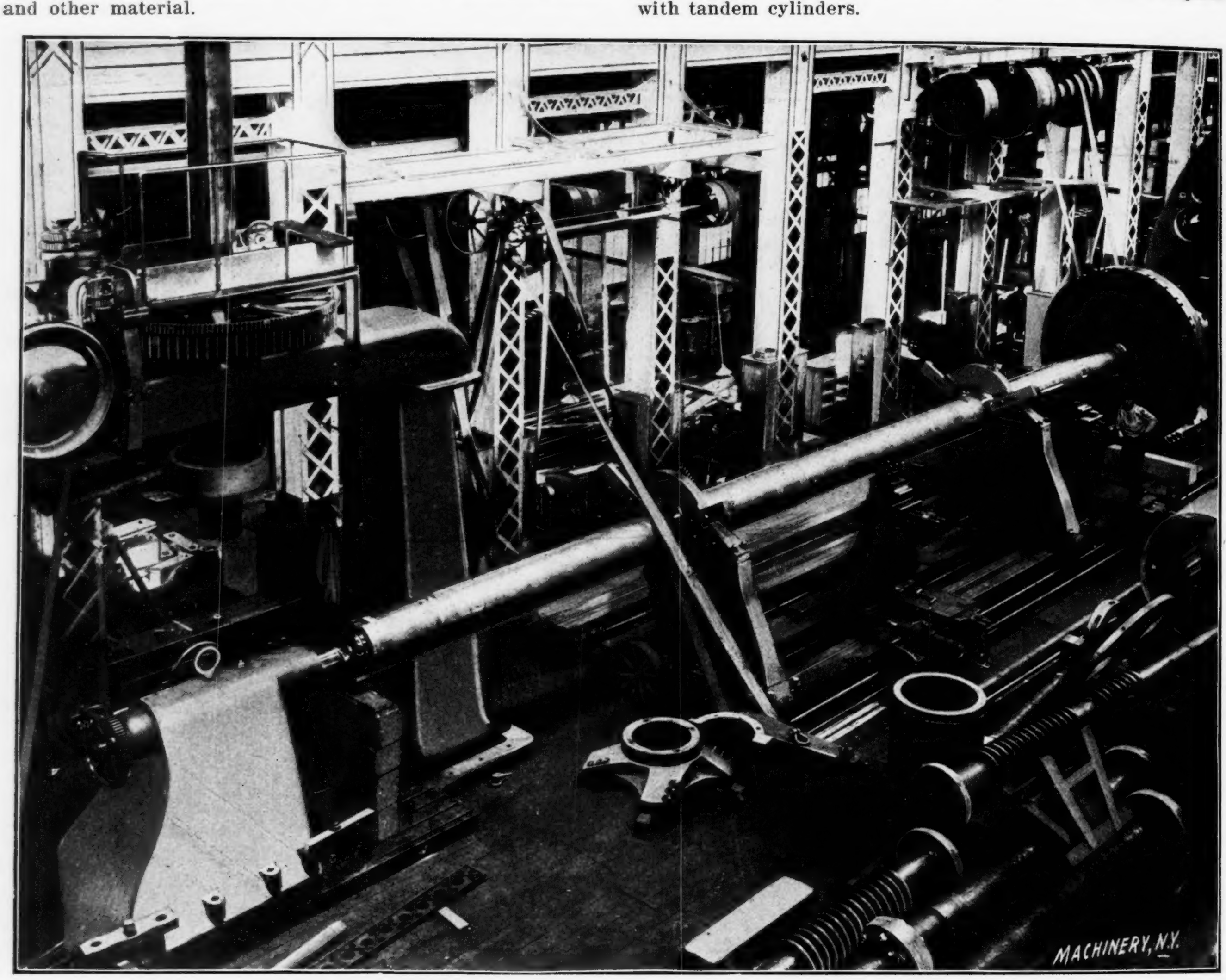


Fig. 2. Turning 22-inch Tail Shaft for Steamship St. Paul, in 125-inch lathe. Tailstock set on base of Sellers 108-inch cylinder boring mill.

There is at present only one drydock in use, but another one is building that will be far larger than any other on this side of the Atlantic. The one now in use is 610 feet long, 130 feet wide at the top and 50 feet wide at the bottom. The new dock will be 827 feet long over all and 806 inside the caisson, 162 feet wide at the top and 80 feet wide at the bottom. The maximum draft over the sill will be 30 feet. The centrifugal pumps for emptying it have vertical instead of horizontal axes and are expected to handle water at the rate of 200,000 gallons per minute, thus enabling them to empty the dock in about two hours. The caisson is being built in the dock on account of the difficulty of launching it, its center of gravity being so high that a special cradle would otherwise be required to keep it upright until it was sufficiently submerged to float on an even keel. The new dock was designed by W. A. Post, the general superintendent, who also assisted in designing the huge

One of the most striking tools is a combined planer and slotter built by Bement, Miles & Co., and shown in Fig. 7, cutting the keyway in the tail shaft of a Pacific Mail steamer. This immense tool planes horizontally 21 feet and slots vertically the same distance. A fifty-horse power electric motor is required to drive it and it is safe to say that the greater part of the power was absorbed on the job in question in overcoming the friction of the machine. This is one of the penalties inseparable from a tool of such great range and power. It is an almost indispensable machine for marine engine work and is kept running night and day, stopping only on Sundays.

The building of built-up crank shafts for quadruple engines so that all parts will be in perfect alignment, is a job of considerable difficulty, as no one having experience along that line will be likely to deny. It is one of the boasts of the machine shop that they have never built an unsatisfactory shaft.

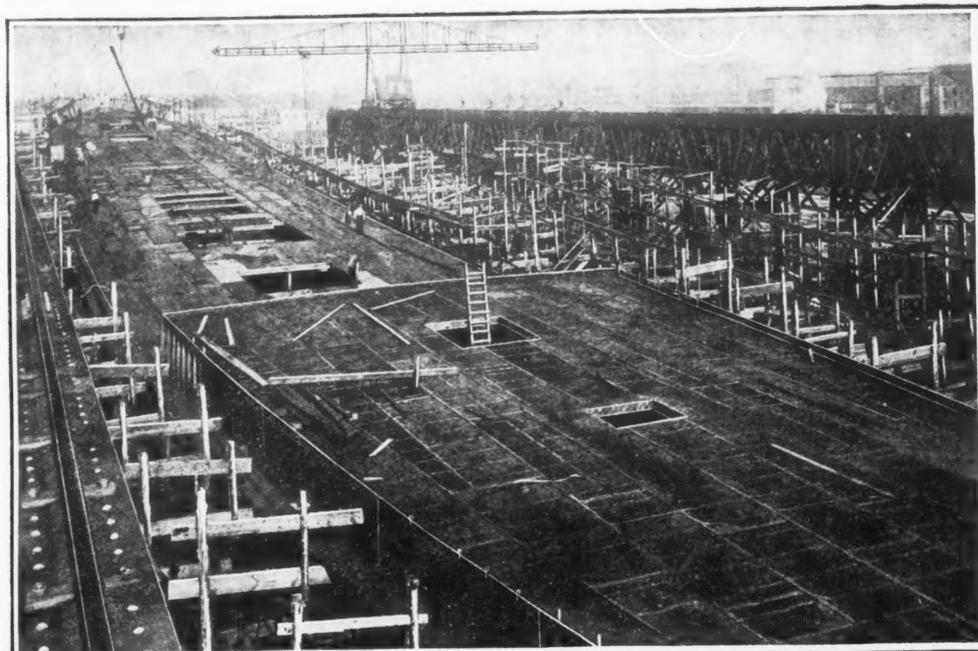
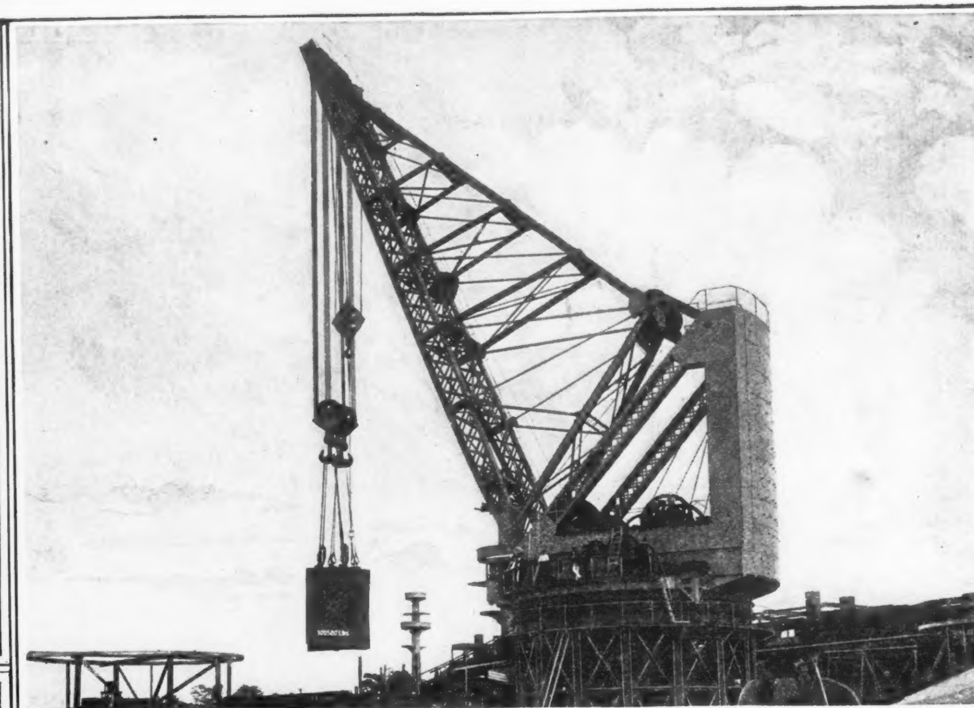


Fig. 3. Pacific Mail Steamer Korea on ways. Displacement 18,500 tons; length, 550 feet; speed, 18 knots; I. H. P., 18,000.

Fig. 5. New Drydock now building, 827 feet over all, 805 feet inside caisson. Caisson building at further end. Total cost, $1,000,000.



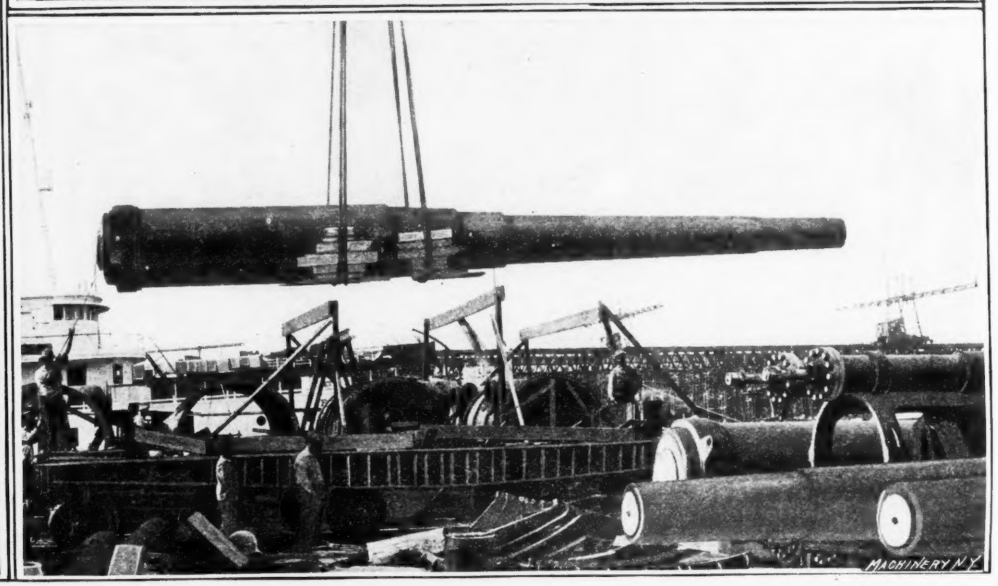


Fig. 4. Electrically-driven Revolving Derrick "Hercules," being tested with 300,500 pounds armor plate.

Fig. 6. Rifled Cannon, weighing 65 tons, for battleship Illinois, being unloaded from flat car to dock.

All built-up crank shafts are assembled by heating the cranks and shrinking them in place. The importance of means that will enable cranks of large dimensions to be equably heated cannot be overestimated in the production of accurate work. A crank having a crankshaft hole 20" in diameter and the one for the pin nearly as large, must be equably heated or else there will be a permanent distortion of extent sufficient to cause serious trouble. For heating cranks an open box mounted on wheels has been constructed of double one-half inch steel plates with about one inch of asbestos between them. The box is perhaps 7 feet long, 4½ feet wide and 2 feet deep. The bottom of the box is double and the upper part is perforated for air jets. An air pipe connects to the air space in the double bottom and another connects to a central burner filled with coke. The crank is laid in this box and coke piled up around it. The central burner is placed in the hole of the crank to be expanded and the two fires started together. In this way a crank is heated very equably in from eighteen to twenty minutes. The double sides filled in between with asbestos prevent excessive heat radiation so that the workmen can approach the apparatus when heating a crank without serious inconvenience.

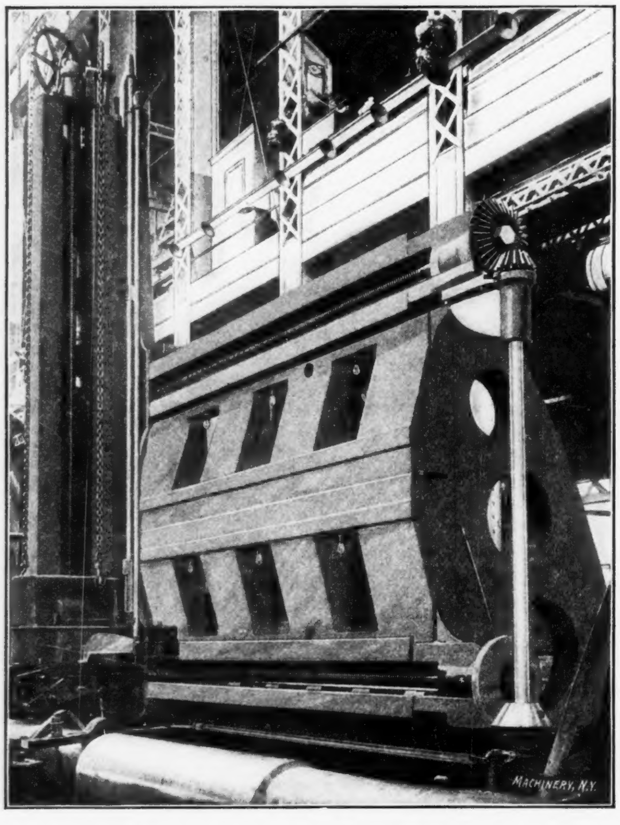


Fig. 7. Combined Planer and Slotter, capacity 21 feet horizontally and 21 feet vertically, cutting keyway in tail shaft.

The manufacture of a tail shaft while not such a complicated operation as that of building a crankshaft, is, however, one on which much depends, as it is one of the most vital parts of a steamship's machinery and probably is the important part that oftenest fails, especially on tramp steamers that make long runs with light ballast.

A tailshaft is subjected to the severest mechanical stresses and also to corrosion, which rapidly becomes of a destructive nature unless the proper means are taken to prevent it. The steel shaft is bushed with bronze liners at its bearings to reduce the frictional resistance and to remove the wear from the shaft to a part that can be comparatively easily replaced. The outboard journal runs in a lignum-vitae box or bearing that supports the shaft next to the propeller. Where the liner ends on the shaft, electrolytic action sets in, caused by the corrosive action of the sea water. It is not practicable to cover the entire shaft with a liner making both liners one, as the torsional stress would quickly disrupt it, and if made in two parts butted together, the sea water soon enters the crack and gets in its work. To prevent electrolytic action the scheme shown in Fig. 10 seems to be the most approved plan. At the ends of the liners, a ring of wrought iron is clamped together in two parts so that it can be readily renewed. The end of the liner is undercut as shown, as is also the end of the iron ring next it, making, when the two are together, a triangular space. After the iron ring is securely clamped in place, a force pump is connected to a hole in the ring and red lead forced in by pressure till the space is solidly filled. The result is that electrolytic action is not prevented, but is transferred from the shaft to the iron ring, which is readily replaced when badly corroded. The liner is shrunk on the shaft and then pinned in place with flush head dowels

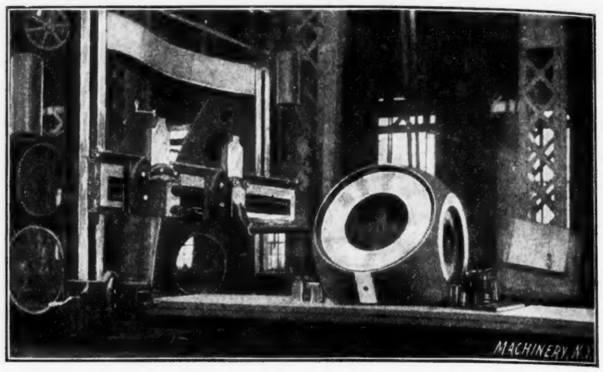


Fig. 8. Cutting keyway in seven ton propeller hub. Reach of tool about four feet.

of the same material as the liner. To prevent electrolytic action at the propeller end of the shaft, the propeller hub is recessed for the shaft and liner and the space around the liner left by the recess solidly calked with oakum. The propeller nut is covered with a brass cap.

Propeller hubs for naval vessels are made of manganese bronze, but those for merchant service are usually steel castings. The one shown on the large Sellers planer in Fig. 8 weighs about seven tons and is designed for three blades. It is for one of the new Pacific Mail steamers. This cut shows a keyseating job of considerable magnitude. The hole through the hub is about 3½ feet in length and tapers 1½" per foot. The width of the keyway is 4½" and total depth in both hub and shaft about the same. It will be observed that the keyway is being cut in the top of the hole. This is necessary on account of the tendency of such a long-reach tool to raise at the clapper-box if it was cut in the bottom. It was also more convenient in this case to cut it at the top.

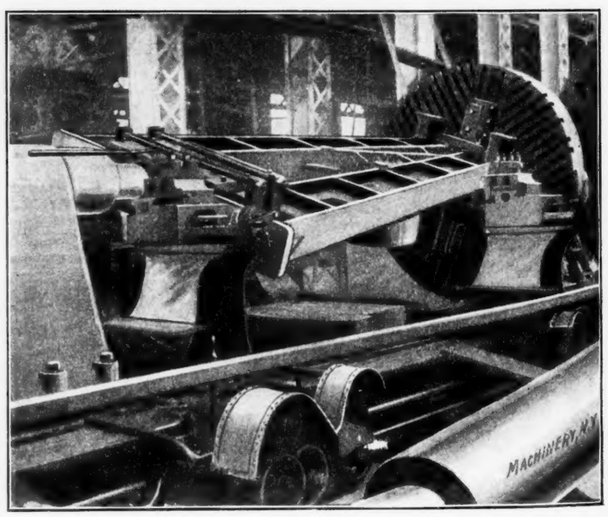


Fig. 9. Facing off feet of cast steel housings in 125-inch lathe.

One of the interesting jobs noted was the facing off of a steel housing in a 125" lathe, as shown in Fig. 9. This housing is one of those used on the engines of the Pacific Mail steamers and is of cast steel. By chipping off the corners at the base, it could just be swung in the lathe without striking the ways. It will be noted that a cast iron piece is fitted between the legs at the base and held by the long bolts. This is merely a temporary center, but it weighs several tons. A large crank weighing about two tons was bolted to the side of the housing

as a counterweight. The foot was being turned off at the rate of about 40 to 45 feet per minute, the tool used being of Sanderson self-hardening steel.

The seats for the propeller blades of such a hub as that shown on the planer in Fig. 8, are faced on a lathe with the hub carried on centers. Where the hub is designed for four blades, the seats are usually faced off on a boring mill. One blade alone for the propellers of the Siberia weighs 8,000 pounds. The total weight of a complete propeller is about 18 tons. The blades are made of bronze and are carefully finished all over, after which they are tinned to prevent corrosion and to always present a smooth surface. The blades are held to the propeller hub by stud bolts tapped into the hub and the holes in the blades are often slotted so that the pitch can be slightly altered after making a trial trip, which is often necessary.

The turning of the longest tail shafts taxes the capacity of apparently be done very advantageously on horizontal milling machines.

Under each gallery is a traveling crane of five tons capacity which traverses the distance of 300′ belonging to the first portion of the shop built. These cranes carry a jib which is turned completely around by power. The operators sit in the center and handle the cranes quickly making them most valuable for both heavy and light work under the galleries. On the main floor are ten swing jib cranes secured to the sides of the galleries which are in most instances operated by hydraulic power.

The outside machine shop is devoted to the special fitting necessary to the installation of machinery and here are also made such parts as heavy hinges for hatches, etc. For merchant work, the hinges are made of iron with a brass or bronze pin, but Uncle Sam will have nothing less than all-brass for the navy.

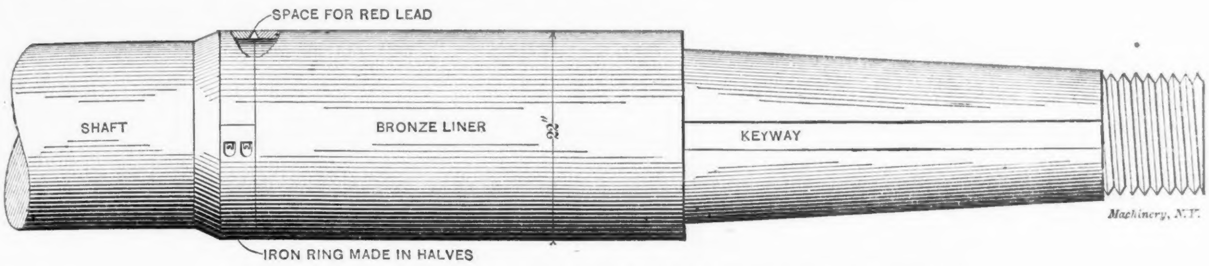


Fig. 10. Showing manner of tail shaft protection from corrosive action of sea water.

the tools, none being quite long enough for the longest ones. The shaft for the St. Paul was turned in the 125″ lathe before alluded to, which has a normal swing of 32′ 6″ between centers, by setting the tailstock on the base of the 9-foot vertical boring mill. As will be noted, it was necessary to move over one housing of the mill out of the way to do this. The lathe commonly used for turning tail shafts is a double ended 63″ lathe, 63′ feet between the two live centers. A third carriage is provided for this lathe and for future work exceeding its normal capacity it is proposed to remove one headstock and set one of the tailstocks at such a position beyond the end of the bed as will swing the shaft to be turned. The carriage for the headstock that has been removed, will be reversed on its ways so that all three carriages will face in the same direction.

The two large cylinders, one on top of the other, shown in the foreground of Fig. 1, are cylinder liners for the large low-pressure cylinder at the right of them and further back. The liners are made so that they bear in the outer cylinder at the ends and at the middle. By making a marine cylinder with a liner, a grade of iron suitable for the interior or working cylinder can be combined with another grade for the exterior portion which may be stronger but not as durable as a wearing iron. All cylinders are bored in the Sellers boring mill mentioned. This huge tool bores cylinders from 48″ to 108″ in diameter and faces flanges to 120″ in diameter. Four tools mounted on a four-armed spider are used when boring and in facing, two tools on opposite cross slides.

The bed plates at the right of the foreground are steel castings and are for one of the Pacific Mail steamers, as are also the liners and cylinder alluded to. The use of steel castings for the housings and bedplates of merchant marine engines marks a distinct advance in American merchant practice. Steel castings make a stronger and more durable construction and also allow a considerable reduction in the gross weight of the engines for the same power.

The galleries of the main shop are used for the lighter classes of work. The south gallery is principally given over to the manufacture of brass work of a light character. One of the departments of this work is the making of brass racks for holding the crockery and similar kitchen appliances. Samples of the various dishes are provided and each dish is fitted to a holder so that it will be securely held in the roughest seas. On the north gallery, brass work of a heavier character is made such as side lights, large and small valves, brass glands, etc. An important part of the work is the manufacture of the necessary electrical fittings which are made of heavy brass. Much of this work which is now done on shaping machines could

The boiler shop is a building 103 feet wide and 300 feet long. It contains a very good equipment for the manufacture of the large shell boilers of the Scotch type so generally used in marine work. Some interesting samples of the work in this line are the Scotch boilers for the Pacific Mail steamers Siberia and Korea which were in process of construction at the time of the writer's visit. Each vessel is to be equipped with six double-ended and two single-ended boilers with Morison suspension furnaces. The diameter of the double-ended boilers is 16 feet and their length, 20 feet 4½ inches. The single-ended boilers are of the same diameter, but only 10 feet 6 inches long. The former boilers contain eight furnaces each and the latter four each, making a total of fifty-six for the eight boilers. The steel shell plates are 1⅝ inches thick with

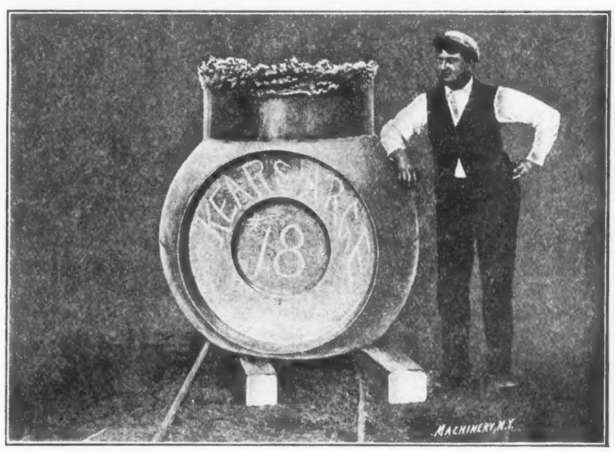


Fig. 11. Manganese bronze propeller hub for battleship Kearsarge, weighing 8,144 pounds when finished.

triple-riveted butt joints having inside and outside covering straps. Each double-ended boiler contains 1,112 tubes and the single-ended ones one-half that number or 556.

In the vessels the double-ended boilers are arranged in threes fore and aft with the two single-ended ones between them. The arrangement is very compactly made so that in a length of say 70 feet, boilers are crowded of a capacity for engines of 18,500 I. H. P. The same boiler power in an ordinary stationary plant would perhaps cover the space of one-half a city block.

Shipbuilding affords the widest field for the use of pneumatic tools and appliances, and here they are fully utilized, both in the shop and on the building ways. All the plates are riveted by heavy pneumatic hammers of a special type. The rivets for the exterior plates all have countersunk heads so as

to reduce skin friction to the lowest possible amount. When riveting the plates in place, the hot rivets are thrust through from the inside and headed down into the countersinks. A rivet must be long enough to completely fill the countersink and in practice somewhat more. As soon as the countersunk head is formed, the operator changes hammers, taking up a small one with a chipping chisel of self-hardening steel and immediately chips off the surface smooth with the plate before the rivet has cooled.

In conclusion it may be said that comparatively few Americans can appreciate what such a plant as the one in question is, without a personal visit to the yard which at the present time represents an expenditure of about $13,000,000. While perhaps the practice of the machine shop could be improved in the way of new and special tools, especially for small work, it must be remembered that the character of the work is materially different from ordinary manufacturing. The general policy appears to be to build all work on honor and to spare no pains to secure perfect construction. The construction of the battleships Kentucky and Kearsarge with the superimposed turrets is a matter of special pride with the builders as they represent a new type which it is thought will revolutionize the present method of battleship construction and which in every way has so far been found worthy of both the builders and designers. The new vessels Siberia and Korea for the Pacific Mail line, each 550 feet long, are to have 18,500 tons displacement and engines of 18,000 I. H. P., which are expected to propel them at the rate of about 18 knots per hour. They will be the largest steamers ever constructed in America and are for trade between San Francisco and Asiatic ports.

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THE SCOPE OF THE PAN-AMERICAN EXPOSITION.

PRELIMINARY INFORMATION ABOUT THE MACHINERY EXHIBITS.

The Pan-American Exposition, to be held in Buffalo during the coming summer, will open on May 1st and continue for six months. Its purpose is to show the progress of the Nineteenth Century in the Western world. The exhibits will be gathered from all the principal states and countries of North and South America and the new island possessions of the United States. It is estimated that the total cost of the exposition, exclusive of exhibits, will be about $10,000,000.

The main features of the buildings and their arrangement are already familiar to most readers of current literature. The general style of architecture is a free treatment of the Spanish Renaissance, by way of compliment to the many Latin-American countries to be represented. The covering and decorative material, here as at other recent expositions, is the plastic staff which is easily molded into various forms. The most striking feature of the grounds is to be the electrical display, partly on account of the proximity of the Niagara power plant and partly because of the remarkable advancement during recent years in the applications of electricity. Other features are to be the elaborate fountain displays, the extensive courts in and about the buildings and the sculptural and architectural effects,—the latter the results of the work of nearly all the leading American sculptors and many noted architects.

One of the largest buildings is the Machinery and Transportation building, which covers an area of about four acres. The Electricity building is nearly as large and the Manufactures and Liberal Arts building, in which will be shown many processes of manufacture, is larger than either. These three buildings will form the centers of attraction for those who wish to become informed about new machinery or the industries dependent upon machinery. In all of these the attempt is to be made to have the exhibits representative rather than exhaustive, and to show the progressive development of important industries, such as nail making, shoe manufacturing, the production of textiles, etc.

Power for the exposition is to be supplied as follows: First, by electric current from the Niagara Power Co. to the extent of about 5,000 K. W. Second, by a power plant of about 3,000 H. P. situated toward the northwesterly corner of the grounds. This plant consists of steam boilers, engines and generators, and the fuel used will be coal. Quite a large variety of engines and boilers will be installed. Third, there is a power plant termed the "Exhibit's Power Plant," situated in the court of the Machinery and Transportation Building, which will produce somewhat over 2,500 H. P. developed by steam and gas engines. The steam will be generated in Climax boilers with natural gas as fuel. All of the installations in the latter plant are purely for exhibition purposes. Something over 30 concerns will participate. The superintendent of the machinery division considered that it was better to exhibit a large variety of ordinary-sized units in which many people are directly interested, or might need for their own purposes, than to use a single large unit which is relatively a curiosity. Such a plan enables one to study the different types at work.

The list of exhibitors for the Machinery and Transportation building is not yet complete, but exhibits from over 300 firms have already been accepted. Of these about 70 are manufacturers of machine tools or appliances for the machine shop. Over 25 automobile manufacturers have already entered their names on the list and it is expected that this department will be exceptionably complete.

The list given below includes most of those who have thus far arranged to exhibit machines, tools and appliances for the machine shop. While it contains the names of many of the largest firms it comprises only a small proportion of the total number engaged in this country in making and selling such tools and appliances. Many more, however, will undoubtedly arrange for exhibits before the grounds are open.

Partial List of Exhibitors.

American Tool & Machine Co., Boston, Mass.
American Blower Co., Detroit, Mich.
Buffalo Forge Co., Buffalo, N. Y.
Builders' Iron Foundry, Providence, R. I.
Bickford Drill & Tool Co., Cincinnati, Ohio.
Bliss Co., E. W., Brooklyn, N. Y.
Bullard Machine Tool Co., Bridgeport, Conn.
Barnes Co., W. F. & J., Rockford, Ill.
Brown & Sharpe Mfg. Co., Providence, R. I.
Belmer Eames Tool Co., Cincinnati, Ohio.
Becker-Brainard Milling Mch. Co., Hyde Park, Mass.
Burt Mfg. Co., Akron, Ohio.
Brown Hoisting Machinery Co., Cleveland, Ohio.
Chisholm & Moore Mfg. Co., Cleveland, Ohio.
Cleveland Ball & Screw Co., Cleveland, Ohio.
Cling-Surface Mfg. Co., Buffalo, N. Y.
Cincinnati Planer Co., Cincinnati, Ohio.
Cincinnati Machine Tool Co., Cincinnati, Ohio.
Cincinnati Milling Machine Co., Cincinnati, Ohio.
Cataract Tool & Optical Co., Buffalo, N. Y.
Cleveland Machine Screw Co., Cleveland, Ohio.
Crescent Steel Co., Pittsburg, Pa.
Carborundum Co., Niagara Falls, N. Y.
Cleveland Twist Drill Co., Cleveland, Ohio.
Chicago Flexible Shaft Co., Chicago, Ill.
Chicago Pneumatic Tool Co., Chicago, Ill.
Dreses, Mueller & Co., Cincinnati, Ohio.
Diamond Machine Co., Providence, R. I.
Detrick & Harvey Machine Co., Baltimore, Md.
Diamond Drill & Machine Co., Birdsboro, Pa.
Faneuil Watch Tool Co., Boston, Mass.
Fox Machine Co., Grand Rapids, Mich.
Ferracute Machine Co., Bridgeton, N. J.
Grant Ball Co., Cleveland, Ohio.
Gisholt Machine Co., Madison, Wis.
Gray & Co., G. A., Cincinnati, Ohio.
Holmes Machine Co., E. & B., Buffalo, N. Y.
Horton & Son Co., Windsor Locks, Conn.
Howard Iron Works, Buffalo, N. Y.
Hart Mfg. Co., Cleveland, Ohio.
Jenkins Bros., New York.
Lodge & Shipley Machine Tool Co., Cincinnati, Ohio.
Long & Allstatter Co., Hamilton, Ohio.
Landis Tool Co., Waynesboro, Pa.
Lunkenheimer Co., Cincinnati, Ohio.
Mietz & Weiss, New York.
Manning, Maxwell & Moore, New York.
Merrell Mfg. Co., Toledo, Ohio.
Morse Twist Drill & Machine Co., New Bedford, Mass.
Niles, Bement, Pond Co., New York City.
Norton Emery Wheel Co., Worcester, Mass.
Oneida National Chuck Co., Oneida, N. Y.
Prentiss Tool & Supply Co., New York City.
Pratt & Whitney Co., Hartford, Conn.
Prentice Bros. Co., Worcester, Mass.
Potter & Johnston Co., Pawtucket, R. I.
Rand Drill Co., New York City.

Roots Co., P. H., Connersville, Ind.
Steel Ball Co., Chicago, Ill.
Shelby Steel Tube Co., Cleveland, Ohio.
Starrett Co., L. S., Athol, Mass.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.
Standard Tool Co., Cleveland, Ohio.
Standard Pneumatic Tool Co., Chicago, Ill.
Universal Machine Co., Providence, R. I.
Walworth Mfg. Co., Boston, Mass.
Waltham Watch Tool Co., Springfield, Mass.
Whitney Mfg. Co., Hartford, Conn.
Washburn Shops, Worcester, Mass.
Williams & Co., J. H., Brooklyn, N. Y.

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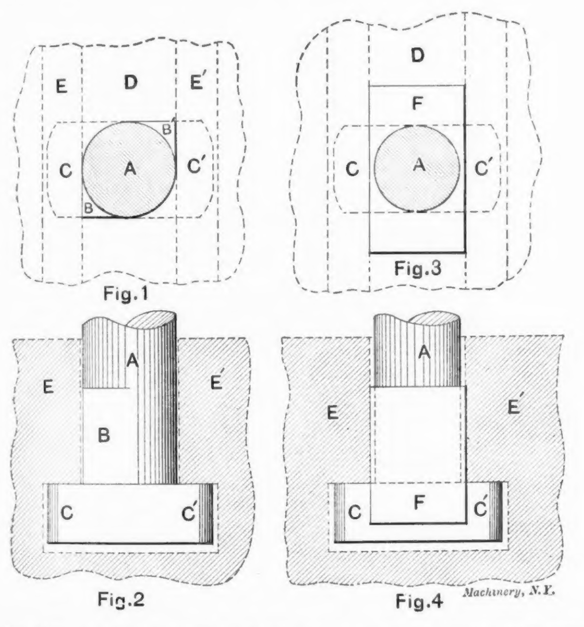
SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP
Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

T-HEAD CLAMPING BOLTS FOR T-SLOTS.

R. P. Perry, Hoboken, N. J., says that the ordinary T-head bolt for clamping work on the platen of a planer, is often a source of annoyance, as it is necessary to start it in at the end of slot. This is inconvenient and takes considerable time, especially if the slot is filled with chips.

Two forms of T-head bolts are shown in Figs. 1, 2, 3, and 4 which can be inserted at any point in the slot and the heads turned to right angles to the slot, which is as far as either can go. There is, therefore, no trouble from the bolt turning around with a tight nut. Figs. 1 and 2 show the plan and elevation of the form that is to be used where the body of the bolt fills the slot. In this case the bolt is made with a square under the head, the sides of which are parallel with the sides of the T-head. Two opposite corners of the square are rounded off, leaving the corners *B* and *B'*. When the T-head is inserted



in the slot *D*, the ends *C* and *C'* can be turned under the wards *E* and *E'* of the slot, 90° from the entering position. The corners *B* and *B'* then strike the wards and prevent further turning. When unscrewing the nut the corners prevent turning the bolt back beyond the entering position.

Figs. 3 and 4 show an arrangement that may be used where the clamping bolts are considerably smaller than the width of the slot. A short piece *F*, a loose fit sideways in the slot, is drilled in the center for the bolt. A slot is cut across the under face at right angles to its length. The slot is of such width as to easily fit over a portion of the width of the T-head. When the bolt is inserted in the T-slot, the head and the piece *F* are parallel, but when the head is turned around under the wards, the piece *F* drops down and prevents further movement, either forward or backward. To remove the bolt the piece *F* is lifted with the fingers until the slot in *F* is disengaged from the head. The latter form of clamping bolt is thought preferable where it can be used, as it does not readily shift its position.

TO KEEP MANDRELS STRAIGHT.

M. H. Ball, Lansing, Mich., writes: "Inclosed is a sketch of a mandrel to be used where mandrels are not hardened, as is often the case, and give trouble by running out of true. The plan is to make a number of spots for the dog or driver by filing or milling a number of flats on one end of the mandrel,

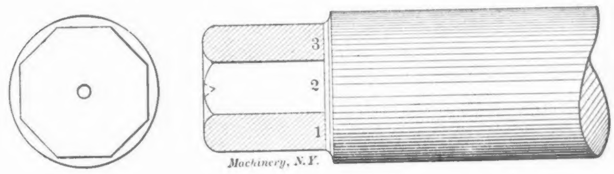


Fig. 5

as shown in the sketch. The flats should then be numbered and when the first piece of work is being turned the driver should be placed on spot No. 1. When the second piece is being turned, the driver should be placed on spot No. 2, and so on, shifting the driver to a new spot each time a piece is started. In turning taper work on a soft mandrel, the latter will generally run out of center very quickly. On certain taper work that I had to do I was obliged to re-center the mandrel after turning from three to eight pieces, but after the mandrel was fixed as described, I finished over fifty pieces without turning the center and the mandrel is still in good condition.

FOR THE DATA SHEETS.

E. J. B. writes: Inclosed is a sketch of a tin case which I find very convenient in the tool room for holding MACHINERY's data sheets. The case is made of heavy tin with edges turned over, into which slide the sheets, and in front of them is a pane of common glass. I find this more convenient than punching, and small blue prints of other kinks may also be kept in the same way. The one being referred to is put in front and after the glass is in place it is not necessary to put dirty fingers on the sheets again.

Fig. 6.

TESTING TOOL–DESIGN FOR SPIDER.

Geo. L. Renneisen, Birmingham, Ala., writes: "One of the most convenient tools to have around a lathe, and one that is rarely found, is a piece of rod brass, about 2" long filed to a point of the shape of a thread tool and of a size to fit the patented tool holders. It is very desirable for trying finished work between centers or in chucking a finished job, as the slightest touch leaves a mark on the job which is easily removed." He also sends a sketch of a spider, Fig. 7, and says that it has many advantages over the one shown in the January number. It can be made of cast iron or steel. The screws are steel with hardened points. This form of spider takes in a large range of sizes since the inner screws can be used on smaller work of about the diameter of the spider by removing the outer screws.

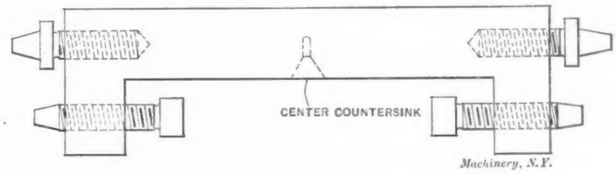


Fig. 7.

TEST INDICATOR.

C. W. Shelley, Lynn, Mass., sends a sketch of a center indicator shown in Fig. 8. The indicator multiplies 35 times. It consists of a frame *A*, on one end of which is a graduated segment and to the other end of which the pointer is pivoted. A sliding pin bears against the short arm of the pointer as indicated, and the pointer is kept at the zero reading of the scale,

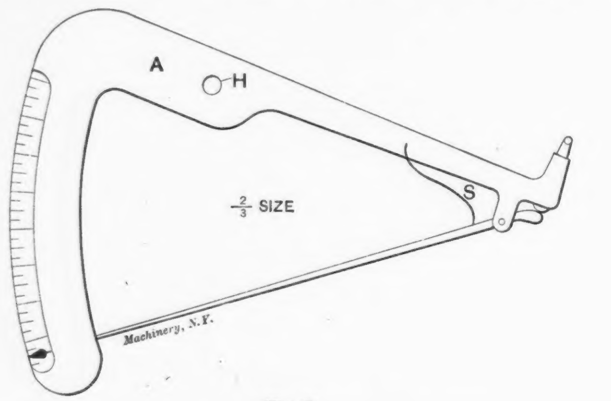


Fig. 8.

by means of the spring *S*, unless it is forced upward by pressure upon the pin. This indicator was originally designed and made by a Mr. Tipples, a toolmaker in Lynn, Mass., and is much appreciated by those who use it because of its lightness. A hole, *H*, in the frame is used to fasten it to a tool holder with a screw. The indicator can be used in a surface gage, and on grinding and milling machines. It has the merit, moreover, of being easily made.

REPAIR JOB.

Robt. Benson, Mobile, Ala., sends a sketch illustrating a repair job that he had to do where there were poor facilities for the work. There had been a fire in a power plant and the pulley on the crankshaft of the engine warped from the effects of the heat and was $3/8$ of an inch out of round after it cooled. The pulley was 10 feet in diameter, and as there was no lathe in town large enough to swing the pulley, it was decided to try to true it up in its own bearings without re-

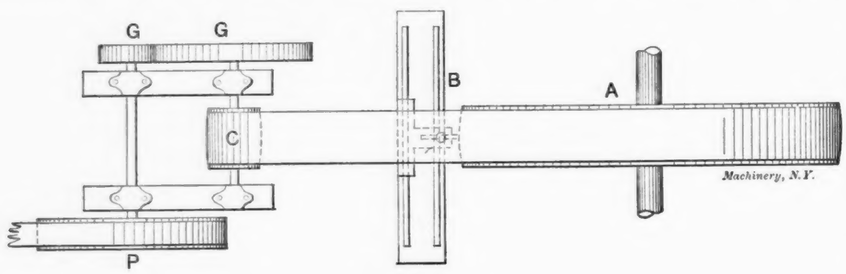


Fig. 9.

moving from the engine room. In the sketch, the pulley is shown at *A*. It was belted to a small pulley, *C*, which in turn was driven through gears *G*, *G*. by a motor that was belted to pulley *P*. The pulley *A* was driven by a 10-inch belt, and pulley *C* was 12 inches in diameter. The gears were in the ratio of about 14 to 1 and pulley *P* was 6 feet in diameter and was driven by a 5-inch belt. A lathe bed, *B*, was set up between the upper and lower sections of the belt running from pulley *C* to the large wheel and by feeding the carriage as the wheel turned, the face of the latter was trued up in a satisfactory manner.

JACK SCREW.

G. P. W., Holyoke, Mass., sends a sketch of a handy jackscrew. The pipe, he says, may be cut to suit circumstances

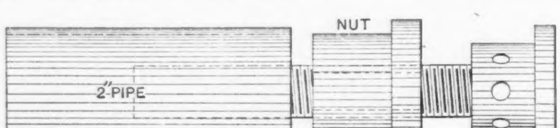


Fig. 10.

and the jackscrew will save hunting for blocking which has mysteriously disappeared.

LATHE DOG FOR SCREWS.

John Moore sends a sketch of a lathe dog to be used on threaded work. The dog is only applicable to one size and pitch of thread, so that for a variety of sizes and pitches, a set of dogs to correspond should be provided. The dog is made

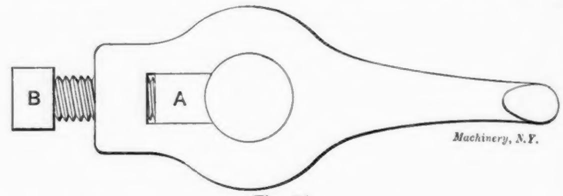


Fig. 11.

with a square block, *A*, under the screw, *B*, and against which the screw abuts. The hole through the dog for the work, is drilled and tapped with the block, *A*, in position. The manner of holding the block in place is immaterial and can be determined in the way thought best by the maker.

* * *

REGULAR VS. IRREGULAR TOOTH SPACING.

For many years hand-cut files were found superior to those cut by machinery simply because the hand-cut file was irregular in spacing and depth of cut while the first machine-cut files were spaced mechanically perfect. The result of such regular spacing is that a cutting tooth follows into the depressions formed by the preceding one, causing the file to "chatter." The hand-cut file having irregularly-spaced teeth, cuts smoothly, as there can be no simultaneous rise and fall of the file as a whole, because the irregularity of spacing does not allow the teeth to exactly register with the impression left by those preceding. This lesson was learned only after a number of file companies for cutting files by machinery had been organized and failed, involving large financial losses.

The same action is noticed in regularly spaced reamers, the best working reamers being those in which the cutters are not regularly spaced. It is also evident in the action of some hack saws. In some makes, the chattering of the saw has a very detrimental effect on the efficiency of the saw and the appearance of the piece cut off. The writer has noticed pieces cut off with a hack saw on which there were a series of grooves 1-8″ apart and 1-32″ deep, running in a diagonal direction across the face of the piece. These grooves were caused by regular tooth spacing, the action being exactly the same as with the regularly spaced machine-cut file. Such work is not creditable to hack saw manufacturers, and is certainly not pleasant to the users of their saws. The obvious remedy, which we believe has been adopted in some instances, is to space the teeth irregularly.

* * *

A big oil well "gusher" has been struck at Beaumont, Texas, which is the wonder of petroleum experts. When the oil-bearing strata, at a depth of 1,300 feet, was pierced by the drill, an attempt was made to conceal the presence of oil in large quantities and to lease adjoining property, but on January 10, 1901, the oil broke loose and shot 200 feet in the air and has since been flowing at a rate which has made it impossible to accurately measure the quantity, but which is estimated at not less than 25,000 barrels for every twenty-four hours. For six days it flowed unrestrained and covered the surrounding land for a mile or more to a depth of two or three feet in the various depressions and in some places there are miniature lakes of oil to considerable extent. The oil from this well is very heavy, having a specific gravity of about 23 degrees, and as it contains some sulphur, it will not disturb the price of illuminating oil, since it will not be as profitable to use it for this purpose as for the manufacturing of lubricating oil and for fuel. In fact, it has such excellent lubricating properties in its crude state, that it can be used with satisfactory results on locomotives and other heavy machinery. As a fuel oil, it is said to be excellent and will be greatly appreciated, as the present price of coal is about $7 in that region.

O. M. & CO.—2.

FURTHER PLANS FOR THE MACHINE SHOP.

Elmer E. Warner.

THE site selected for the O. M.'s general machine shop was admirably suited for such an enterprise. But three miles west of a thriving manufacturing city of fifty thousand inhabitants, it lay just beyond the confluence of two streams, the larger of which, a river, circling toward the south on its eastward journey, had left a broad expanse of open meadow in the bend, sloping slightly from the north down to the river's brink. The P. D. Q. R. R. cut off and bordered this bend on the north in its air line for the west. The smaller of the two streams came down from a low range of mountains paralleling the railroad on the north, crossed it just east of the site of the shop, and meandered down to the river, some three hundred feet away. Along the nearer side of the river ran a good macadamized roadway. (Note—There are both good and bad macadamized roadways), and a trolley road connecting the towns farther up the valley with the city just below. The land to be covered by the building was almost level, being upon the summit of the slight divide separating the two water-courses.

It was shortly after the O. M. Company had been successfully launched in financial circles. The land just described, including some twenty acres to the east, west and north, had been quietly purchased at about three hundred dollars per acre, and the O. M. and his young adviser sat in the former's dingy office, discussing plans for the new shop. The O. M. had sketched out a barn-like structure, principally wood, with little glass, built right down on the ground. Said he could put it up for fifty cents a square foot, and thought it "just as good as if it was better." The Y. M. had looked it over and started in to lay the proposition out.

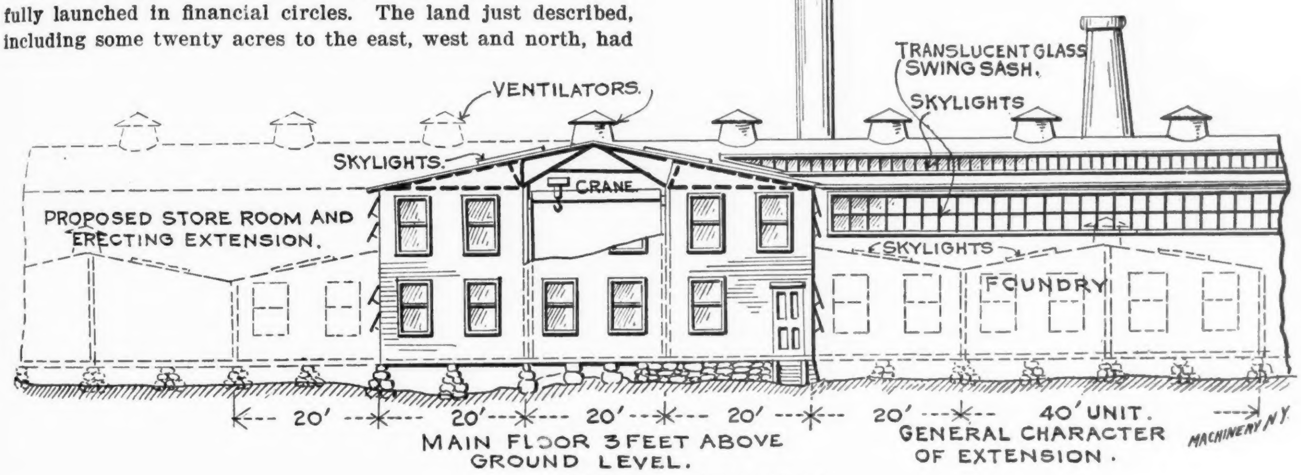
"I'm going to hit you pretty hard, O. M., on this plan of yours. We don't want a wooden shanty, set on the dirt. It might outlast you, but not me, eh, O. M.? And you wouldn't feel respectable in it, any way. Now, let me give you a little home-made logic that goes right back to the heart of our problem. We're in business to make something, and we need a lot of machines to do it, and the most costly of those machines pay poll taxes and sign Christian names to pay checks.

"Here's a lathe, now, cost five hundred dollars. Interest on investment, twenty-five dollars a year. Takes a horse power to run it, and costs about forty, say. Depreciation, about ten—total, seventy-five dollars a year. Here's the man that runs it. Cost, fifteen dollars a week, or $780 per year. $780 as against $75—about ten to one.

"Now, that lathe may run just about as well in any old shop, but the man won't. That's my argument. Too cold—he stiffens up; too hot—gets stupid; too dark—can't see. You've got to make him comfortable. It's Christianity and common sense. Makes the difference between profit and loss on that man, just how he's treated.

"Now, we want a shop that will last; one warm in winter and cool in summer; one with good, clean, comfortable board floors, with space below for electric wires, drain-pipes and ventilation. Here's a little sketch of the elevation. Steel frame, light, but strong. Steel floor beams, laid on stone piers. Posts ditto. Plenty of stone in the hills behind us. Good stone foundation-wall along our permanent boundaries with ventilating gratings. On the lines of expansion, that is, east and west of south wing, we will just bank up the earth between the piers, sod over, and put in flower-beds. Floors, three-inch hemlock overlaid with two thicknesses of building-paper; over that, inch and a quarter straight-grained matched yellow pine of the best quality, laid diagonally. Walls, pressed-fibre paneling, with expanded metal core leaded into angle-iron framing. Light, strong, won't burn, holds paint well, and a good non-conductor of heat and cold. We'll put in panels three by five feet, an inch thick. Whole thing sectional, and east and west wall of south wing easily moved out when we expand.

"Windows and skylights all of heavy, translucent glass, gold tinted. Surprising what a sunny interior you get under the grayest skies with a little amber in your glass. Makes a fellow feel cheerful and like working all the time. And there's no glare—positively no glare at noontime—just a steady, strong, diffused light through the whole shop. Beats a saw-tooth interior all hollow. We'll hinge our sash at top and have them swing out at bottom with this positive worm movement. This gives air without direct sunlight, and does away with inside shades to get torn and dirty. Shades are a device of the devil, any way. One man wants them up, another down, and then there's —— to pay.



GENERAL ELEVATION.

"Air in at the sides and out at the peak, through these big ventilators—that gives you a good circulation. Put in a round, pivoted damper at base of ventilators, so you can readily close them in cold weather, too.

"Now we've covered light and air for main building. Let's consider heating next. With our lay-out, it's my opinion that steam coils, suspended from ceilings will give the best results. We'll hang a liberal area of inch-and-a-quarter pipe under the galleries and some along north side of foundry. Some near eaves, along galleries, too. Might as well use our exhaust steam this way, and the ceiling is the most out-of-the-way and get-at-able place. Boilers will be set six feet below first floor level, so our water-line will be below steam coils.

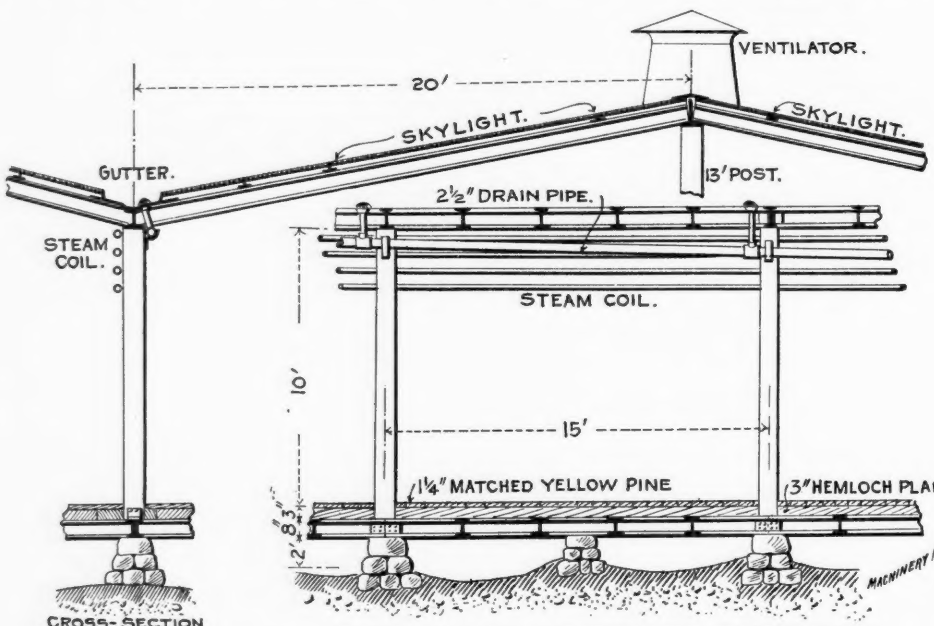
"Now just a word about our extensions. Got 'em marked down in dotted line, you see. The big wing toward the west we may have to use partly for an erecting and blacksmith shop. Our biggest machine comes inside of eight tons now, but units grow these days. Got a good plan for a twenty-ton

thirty-foot traveling crane, right up against the roof of this extension. For general machine space, we can push out a twenty-foot bay on east and west side of south wing, and then work east and west with this forty-foot section as a unit, up to the ends of the east and west wings. That gives us 200 by 260, or 52,000 sq. ft. on the main floor. Guess it will be a long time before we make such a spread—eh, O. M.? Our closet partitions will be sectional iron panels seven feet high, with a blind entrance—no door—galvanized iron covered floor and best flushing arrangements.

"Tool-rooms, stamped sheet-iron panels to a height of three feet above floor. Above this to ceilings, white enameled wire-work diamond mesh. We'll paint our whole interior a cream-white with terra cotta trimming around posts and walls to a height of one foot from floor. Outside walls bronze yellow, roof dark red.

"Office and drawing-room partitions, glass and stamped sheet-iron. From your office there, O. M., you can survey the whole establishment, practically.

"How about drainage for rain, snow, etc., on extensions? Oh, that's easy. Here's a section of the gutter. Our posts, you see, are fifteen foot centers, north and south. Near each one we drop a two-inch pipe into a two and a half, running with a good pitch north; this again connecting into a three,



CROSS-SECTION OF EXTENSION. LONGITUDINAL SECTION OF EXTENSION ON GUTTER LINE.

joining these at the ends. Our skylights are up well toward the peaks, so that the heaviest falls of snow won't more than half cover them. Easy matter any way to shove it off toward the gutters, and by making a steam connection to our draining system we can melt out ice or snow easily enough if necessary. We don't get much snow in this latitude any more, any way, and it will pay to keep steam on all night for a cold snap.

"Now, O. M., don't you think this fixes us up pretty well for a starter? And we can pull out our side panels and widen out our floor space without expensive alterations when we get the business. And its all straight work. Not an extra joint, angle or size of material anywhere. We can get the whole shell put up on close contract and fit up interiorly as we develop our plan and business. Cost? About two dollars a square foot for one story, three with gallery. But don't let that worry you, O. M.! We'll get it all back."

But the O. M.'s face wore a look of settled gloom. His hands sank deeper into his pockets, as if in a vain attempt to discover the wherewithal for this gigantic undertaking, and the Young Man abruptly changed the subject.

* * *

The Cornell Society of Mechanical Engineers, Ithaca, N. Y., is a new society organized last fall by the students at Sibley College, Cornell University. The object of the society is to promote the interests of mechanical engineering among its members.

HIGH SPEED GEARING.

It is sometimes necessary to use gear wheels for the transmission of power, which must run with both high peripheral speeds and high pressures per unit of tooth contact. Under these conditions there is likely to be abrasion of the tooth surfaces. The curved surfaces slide upon each other as they enter and leave contact and there is more or less impact, especially when the resistance fluctuates or the loads are suddenly applied. This hammering action flattens the curves of the teeth, after which proper engagement ceases and the gears are destroyed.

In the last proceedings of the Engineers' Club, of Philadelphia, James Christie refers to this trouble with gears working under heavy duty and offers some suggestions for designing such gears. Owing to the low elastic limit of cast iron and the bronzes, these metals will not endure so high a pressure as steel. Soft steel, however, abrades very readily, despite all methods of lubrication, and surfaces of this material should not be allowed to engage in sliding contact. Gearing of soft steel is usually destroyed by abrasion at quite moderate speeds. Rolling mill pinions of steel, containing 0.3 per cent. carbon, have been destroyed in a few months, whereas the same pattern in steel of 0.6 per cent. carbon has done similar work for several years without distress.

Mr. Christie says: "It appears to be practicable to maintain sliding surfaces of steel if one of the surfaces is hard, even if the other is comparatively soft; but for steel gearing for ordinary purposes I would suggest the use of steel not less than 0.4 carbon. If the speeds and pressures are unusually high, a much harder grade of steel becomes necessary. When a small pinion engages with a large wheel, the former alone can be made of a high-grade steel approaching to a carbon content of 1 per cent. When extreme speeds and pressures become necessary, the best results will be found by using in both wheels steel having a carbon content approaching 1 per cent., or an equal hardness, obtained by lower carbon and high manganese or other desirable hardening addition. With gearing accurately cut from steel of this character and securely mounted, it is believed that reasonable endurance will be obtained when the product of speed and pressure, divided by pitch, each within certain limits, does not exceed 1,000,000: for example, a speed of 3,000 feet per minute and 1,600 pounds pressure per inch of face, or vice versa, for gear of 5-inch pitch, assuming, so far as we know, a maximum speed of 5,000 feet per minute for gear of any pitch, and permissible pressure to be proportional to the pitch.

"This statement that speeds and pressures are reciprocal, or as one is increased the other must be reduced, in a fixed ratio, may not strictly be a rational one, but in a broad and general sense it is correct within the usual limits of practice."

An instance is referred to of gear wheels for a rolling mill with diameters 37.6" and 56.4", pitch 4.92", face 24". The pinion was forged from fluid compressed steel containing 0.86 per cent. carbon and the spur wheel was an annealed steel casting containing 0.47 per cent. carbon. Ultimately the wheels were run with a pressure of nearly 2,100 pounds per inch of face and a maximum peripheral speed of 2,500 feet per horse power, transmitting about 33,000 horse power.

* * *

All tall buildings sway somewhat with the wind, passing railroad trains or the movements of heavy machinery on the upper floors, especially when the reciprocating parts of several machines are synchronized so that they move in unison. The swaying of high buildings and steeples is not a defect, but indicates that the supporting members are under equal compression on all sides.

BELT DRIVE FOR THREE PULLEYS.

CALCULATIONS WHERE TWO PULLEYS ARE DRIVEN WITH A SINGLE BELT BY A THIRD PULLEY.

FORREST R. JONES.

It not unfrequently happens in practice that a belt drive must be so arranged that a single driving pulley will transmit power to two driven ones by one belt which wraps continuously over all three, the rotation of the driven ones being in opposite directions. The determination of the total tensions in the different stretches of belt, and of the sectional area of the belt, involves some principles which do not enter into the more common case of finding the tensions and size of belt for only two pulleys directly belted together.

In order to bring clearly to mind the principles involved in belt design before taking up the real problem to be considered, the calculations for a couple of two-pulley belt drives will first be made. The following symbols are used for the sake of a convenient notation:

N = revolutions of pulley per minute;

P = total turning force which must be exerted tangentially to the pulley face by the belt, pounds;

T_1 = total tension in tight side of belt, pounds;

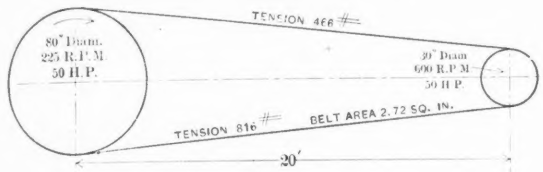


Fig. 1

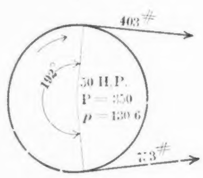


Fig. 2

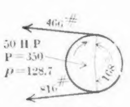


Fig. 3

Machinery, N.Y.

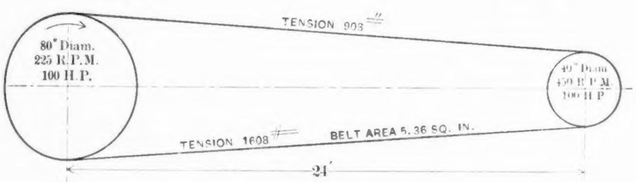


Fig. 4

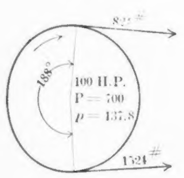


Fig. 5

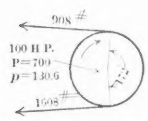


Fig. 6

Machinery, N.Y.

T_2 = total tension in slack side of belt, pounds;

V = velocity of belt, feet per minute;

p = turning force which a belt of 1 square inch sectional area would exert tangentially to the face of the pulley under the same conditions as those for the actual belt, pounds;

t = tension, pounds per square inch, at which the belt is to work on the tight side in a two-pulley drive; also, the tension in pounds, per square inch, for the stretch of belt subjected to the greatest total tension in a three-pulley drive;

w = weight of 1 cubic inch of belt, pounds;

a = angle of contact (or wrap) of belt about a pulley, degrees;

f = coefficient of friction between the surfaces of the belt and pulley;

π = 3.1416.

Fig. 1 represents two pulleys of 80 and 30 inches diameter, and 20 feet between centers, between which 50 horse powers are to be transmitted by a flat leather belt. The 80-inch pulley is to run at 225 R.P.M., which corresponds to 600 R.P.M. of the 30-inch pulley. The cross-sectional area of the belt is required. The method of solution and the result would be the same for either pulley as the driver.

The angles of contact, Figs. 2 and 3, as measured on a drawing with a protractor, are:

$$a = 168^\circ \text{ for the } 30'' \text{ pulley,}$$

and

$$a = 192^\circ \text{ for the } 80'' \text{ pulley.}$$

The velocity of the pulley face is obtained by the equation

$$\begin{aligned} \text{Velocity of pulley face} &= (\text{rev. per min.}) \times (\text{circumference}) \\ &= N\,(\pi \times \text{diam.}) \\ &= 225 \times 3.1416 \times \tfrac{80}{12} \\ &= 4712 \text{ feet per minute.} \end{aligned}$$

The total tangential turning force, P, is obtained by use of the expression,

$$P = \frac{33000 \times \text{horse powers}}{\text{velocity of pulley face}} = \frac{33000 \times 50}{4712} = 350 \text{ pounds.}$$

The same amount of turning force, 350 pounds, must be applied to each pulley.

The turning force, p, that a belt of 1 square inch sectional area will exert tangentially upon a pulley face, is determined by the expression:

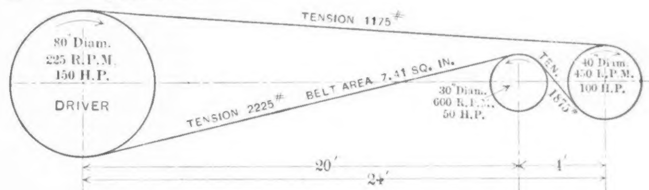


Fig. 7

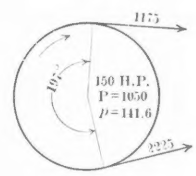


Fig. 8

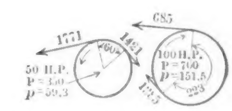


Fig. 9 Fig. 10

Machinery, N.Y.

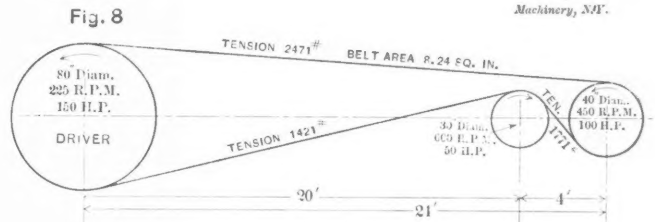


Fig. 11

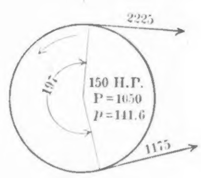


Fig. 12

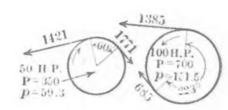


Fig. 13 Fig. 14

Machinery, N.Y.

$$p = (t - .0001036\, w\, V^2)\,\frac{10^{.00758\,fa} - 1}{10^{.00758\,fa}}$$

The tension per square inch, which can be used with economy of good belting for a steady full load, may be taken as t = 300 pounds. The weight of good belting can be taken as w = .035 pounds per cubic inch. The coefficient of belt friction, f, is an excedingly uncertain and variable quantity, but .3 is safe for a belt in fair condition.

On account of the thickness of the belt, its average velocity is somewhat greater than that of the pulley face, not allowing for slipping. To be on the safe side the speed of the belt may be taken as,

$$V = 4{,}720 \text{ ft. per min.}$$

Substituting these values reduces the above expression, taking $a = 168^\circ$ for the 30" pulley, to

$$\begin{aligned} p &= [300 - .0001036 \times .035\,(4720)^2]\,\frac{10^{.00758 \times .3 \times 168} - 1}{10^{.382032}} \\ &= (300 - 80)\,\frac{2.4101 - 1}{2.4101} \\ &= 220\,\frac{1.4101}{2.4101} = 128.7 \text{ pounds.} \end{aligned}$$

In the right hand member of the equation, the exponent

$$0.00758 \times .3 \times 168 = .382032.$$

The value $10^{.382032} = 2.4101$ **is obtained by first finding the quantity .382032 in the body of a logarithm table, and then the number 2.4101 corresponding to this logarithm.**

The total turning force that must be exerted by the belt upon the pulley for transmitting 50 H.P is, as already calculated, $P = 350$ pounds. The turning force which a belt of 1 square inch sectional area will exert has also been calculated for the 30" pulley, and thus found to be $p = 128.7$ pounds when the belt works at $t = 300$ pounds tension per square inch. The total tension on the tight side of a belt for a turning force of 350 pounds will be

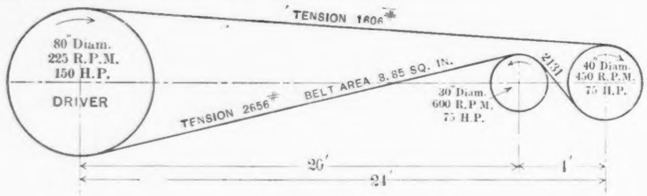


Fig. 15

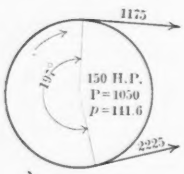


Fig. 16

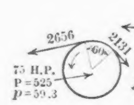
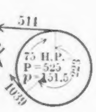



Fig. 17 Fig. 18

Machinery, N.Y.

$$T_1 = \frac{350}{128.7} 300 = 816 \text{ pounds.}$$

The difference in the tensions on the tight and slack side is equal to the turning force exerted upon the pulley. In order to find the value of the slack side tension it is therefore only necessary to subtract the turning force from the tight side tension, thus,

$$T_2 = T_1 - P = 816 - 350 = 466 \text{ pounds.}$$

These values of T_1 and T_2 are shown in Fig. 3.

For the 80" pulley a similar method is applicable. The only quantity that has a different value from those already used is the angle of belt contact, which is 192° instead of 168°. Solving as before:

$$p = 220 \frac{10^{.00758 \times .3 \times 192} - 1}{10^{.436608}}$$

$$= 220 \frac{1.7328}{2.7328} = 139.5 \text{ pounds.}$$

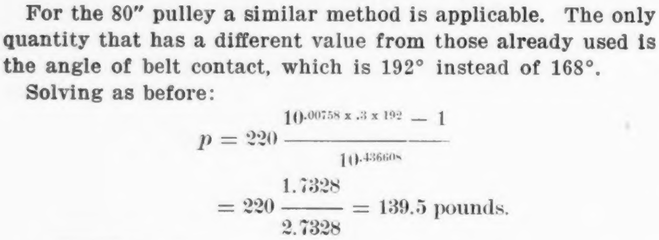


Fig. 23

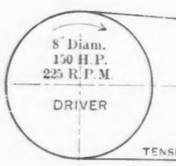


Fig. 24

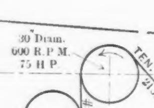
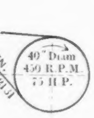



Fig. 25 Fig. 26

Machinery, N.Y.

$$T_1 = \frac{350}{139.5} 300 = 753 \text{ pounds.}$$

$$T_2 = 753 - 350 = 403 \text{ pounds.}$$

T_1 and T_2 for the larger pulley are shown in Fig. 2.

The sectional area of the belt is equal to the quotient of the greatest tension necessary, divided by the working tension per square inch, or,

Sectional area of belt = 816 ÷ 300 = 2.72 square inches.

A belt ¼" thick would have to be 2.72 ÷ ¼ = 10.88", say 11", wide; a 5-16-inch belt would be 8.7", say 9", wide.

To transmit 100 H.P. from the same driver at the same speed to a pulley 40" in diameter with 24 feet between pulley centers (the same arrangement as in Fig. 4), the following are the values of the quantities entering into the calculations for the smaller pulley: $a = 172°$; $p = 130.6$ pounds; $= T_1$ 1,608 pounds; $T_2 = 908$ pounds; sectional area of belt 5.36 square inches. These values are shown in Figs. 4, 5 and 6.

Three-pulley Drive.

In Fig. 7 three pulleys of the same diameters as those already used are placed in tandem so that one belt can be wrapped over all three of them in succession. The size of belt with which the 80" pulley can drive both the 30" and 40" ones, is to be determined. The distance between the driver and each of the driven pulleys is taken as before, and the amount of power to be delivered to each driven pulley is the same as was previously used. As shown in Fig. 7, the 80" driver and the 40" driven pulley both rotate clockwise while

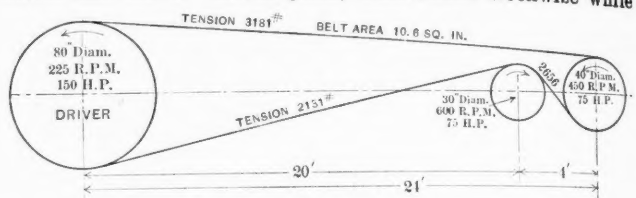


Fig. 19

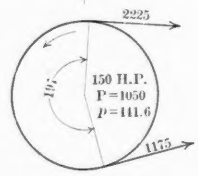


Fig. 20

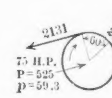
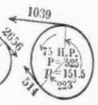



Fig. 21 Fig. 22

Machinery, N.Y.

the 30" pulley necessarily turns in the opposite direction. The 80" pulley must ,of course, deliver to the belt the total 150 H.P. which are received by the two driven pulleys. The speeds of rotation and other assumed quantities are the same as before.

The turning force which the driver must deliver to the belt is, for the 150 H.P.,

$$P = \frac{33000 \times 150}{4712} = 1050 \text{ pounds.}$$

The angle of contact is 197°, for which $p = 146$ pounds; the belt tensions are $T_1 = 2{,}225$ pounds and $T_2 = 1{,}175$ pounds.

For the 30" pulley the angle of contact as shown in Fig. 9 is 60°; for this angle $p = 59.3$ pounds; the turning force to be exerted by the belt upon the pulley remains as before, $P = 350$ pounds and requires the total tensions, $T_1 = 1{,}771$, and $T_2 = 1{,}421$ pounds.

On the 40" pulley the angle of contact is 223°, for which

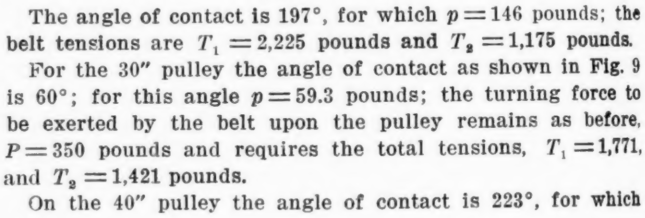


Fig. 27

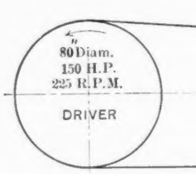


Fig. 28

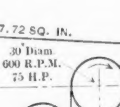



Fig. 29 Fig. 30

Machinery, N.Y.

value: $p = 151.5$ pounds; $P = 700$ pounds as before; $T_1 =$ 1,385 pounds, and $T_2 = 685$ pounds.

Unlike the two-pulley belt drive, it is impossible to select at a glance the maximum tension which will exist in the belt in order to transmit the power as required. It becomes necessary therefore to assume that the tension in one clear stretch of belt between two pulleys will be the larger of the two amounts which have been calculated for that stretch. In accordance with this it may be assumed that, in the lower stretch of belt running from the driver, the tension will be 2,225 pounds. This, of course, will make the tension on the tight side of the 30" pulley also 2,225 pounds, while on the slack side of the 30" pulley it will be 2,225 — 350 = 1,875 pounds. This is a greater tension than the 1,385 pounds cal-

culated for the tight side of the 40″ pulley. The tension on the tight side of the 40″ pulley must be the same as on the slack side of the 30″ pulley, since the belt is a single stretch between these parts of the two pulleys. By thus making the tension 1,875 pounds on the tight side of the 40″ pulley it becomes $1{,}875 - 700 = 1{,}175$ pounds on the slack side of the 40″ pulley, which is the same, of course, as upon the slack side of the 80″ driver.

Using the total tensions of 2,225 pounds, 1,875 pounds, and 1,175 pounds makes the tension in each stretch of belt either equal to or greater than the amount calculated for each given stretch; the belt therefore will drive all the pulleys when working at a unit tension $t = 300$ pounds per square inch between the large and small pulleys.

Now suppose that, all other conditions remaining as before, the directions of motion are reversed so as to be as indicated in Fig. 11. The tight and slack sides upon each pulley are interchanged but T_1 and T_2 retain the same values in each case. The tensions, calculated for each pulley considered individually, are shown in Figs. 12, 13, and 14.

The tension in the stretch between the driver and 30″ pulley must be at least 1,421 pounds, the amount calculated for the tight side of the 30-inch pulley. This makes the tension on the top stretch $1{,}421 + 1{,}050 = 2{,}471$ pounds, which is great enough for both the driver and 40″ pulley. The tension between the 30″ and 40″ pulleys is 1,771 pounds as calculated for the smaller.

Again suppose that, all other conditions remaining unchanged, each of the driven pulleys is to receive 75 H.P., the total amount of power transmitted being 150 H.P. as before. For clockwise rotation of the driver, as shown in Fig. 15, the total belt tensions for the 30″ pulley considered alone are 2,656 and 2,131 pounds; for the 40″ pulley, 1,039 and 514 pounds. By taking the 2,656 pounds tension on the tight side of the 30″ pulley as a starting point for obtaining the maximum total tension which must exist in the belt, it can be seen that, using this value and the corresponding $T_2 = 2{,}131$, the tensions in all three stretches of belt will be sufficiently large. This gives a belt area of 8.85 square inches cross section.

Reversing the direction of rotation, as shown in Figs 19, 20, 21 and 22, it can be seen that in a similar manner the tension which must be maintained in the upper stretch of belt is $2{,}656 + 525 = 3{,}181$ pounds; the corresponding belt area is 10.6 square inches.

Since the total tension in the belt for the power transmitted and the arrangement of pulleys just given depends upon the tension necessary for the 30″ pulley, its reduction can be effected by the introduction of an idler to increase the arc of contact on the 30″ pulley, as shown in Fig. 23. This idler is so placed in this case that the belt stretches coming to it are horizontal and vertical. The frictional resistance at the supporting bearings of this idler, and all other losses of power incident to its introduction, are neglected in determining the belt tensions. The values of T_1 and T_2 for each working pulley are as shown in Figs. 24, 25, and 26. An examination of these will show that the 2,315 pounds necessary on the tight side of the driving pulley will be more than sufficient for the other two. This gives the belt area of 7.72 square inches.

Reversing the direction of motion it will be seen, as shown in Figs. 27, 28, 29, and 30, that the same tension of 2,315 pounds is sufficient, and that, consequently, the belt area of 7.72 square inches answers for driving in this direction as well as the other.

The frictional loss occasioned in the idler would, with ordinary kinds of machinery kept in fair order and reasonably well lubricated, be less than the difference between that in the main journals when no idler is used and when it is not. The idler friction will, of course, be larger when driving clockwise than in the other direction. For driving counter-clockwise the introduction of the idler would allow a saving of $10.6 - 7.72 = 2.88$ square inches of belt section, as shown by the values in Figs. 19 and 27. Without the idler the belt must be more than 37 per cent. larger than with it. The saving of belt area for clockwise rotation of the driver would be $8.85 - 7.72 = 1.13$ square inches, a much smaller amount than for rotation in the other direction. The advisability of using an idler depends upon the conditions peculiar to each installation.

The coefficient of belt friction, f, may often be safely taken higher than the value of .3 used in the foregoing problems, especially if the belt is well cared for and has a suitable belt dressing applied at times. Under such conditions $f = .4$ or even more can be safely counted upon for a small amount of slip on the pulley face. A high rate of slip gives a higher coefficient of belt friction, but the slip is generally seriously objectionable. It is reported on good authority that unusually high coefficients of belt friction have been obtained by the application of a certain brand of belt dressing.

When the load upon the belt remains at its maximum value for only a short portion of the working time, a much higher working tension than $t = 300$ pounds per square inch can be used if the belt is designed for its maximum load. Such a condition exists in a belt-driven dynamo for electric lighting which carries its full load for only an hour or two out of the several during which it operates daily. The balance between economy of first cost and interest on investment for the pulleys, as well as the belt, is in favor of working the belt at a higher tension for full load, and, consequently, with less durability. The life of a belt should be practically of the same length whether operated under a constant or variable load.

* * *

ITEMS OF MECHANICAL INTEREST.

NOTES GLEANED FROM VARIOUS SOURCES.

An inquirer in *Sparks* asks about the action of case-hardening compounds upon iron and steel. He wishes to know whether the compound serves to open the pores, thus allowing the surface to take the chill of the bath, or whether it is the compound itself that does the hardening. To this R. A. McDonald, of the Crescent Steel Co., replies that it is only necessary for one to fix in his mind that the element lacking in iron or soft steel to help it to harden is carbon, and this is where the case-hardening compound comes in. The principal element in the compound is carbon, and when the iron or steel is packed in this and then the whole mass is heated to the proper heat, the carbon enters into the articles and the surface practically becomes steel. It is simply the old process of cementation or conversion of iron into steel by packing in charcoal and heating until the iron absorbs sufficient carbon to become "blister steel" and be susceptible of hardening by heating and chilling.

While lead and iron pipe have taken the place of the old log pipes of former days, there are still uses for which wooden pipe is better adapted than any of the metal pipes. *The Woodworker* states that a new kind of wooden pipe has been brought forward at Spokane, Wash. Each length is made up of staves, wound with galvanized steel wire under tension. The sizes are made 2 to 8 inches internal diameter. The staves are kiln-dried Oregon fir, ⅞ inch to 1½ inch thick. Joints are made with a male and female socket on the small sizes, and a sleeve and butt joint on the larger sizes. Some 8-inch pipe of this type, wound with No. 4 copper wire, has been tried in the mines of Butte, Mont., where the acid water rapidly destroys ordinary pipes, and with excellent results. This pipe has been tested to 500 pounds pressure. The price of this class of pipe in the locality where it is used is said to be 15 to 50 per cent. below the price of iron pipe.

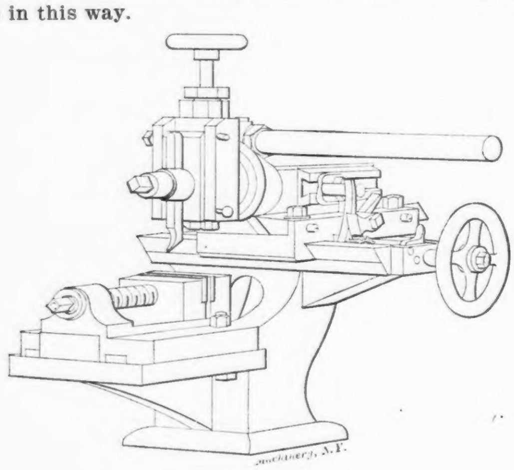
BALL BEARINGS FOR WATCHES.

The operation of timepieces, especially watches, is radically affected by the frictional resistance of the mechanism. It is evident that in a watch train, the pressure due to the mainspring at the escapement wheel must be very slight indeed, so any undue frictional resistance in the train in this vicinity must necessarily retard the action if not actually prevent the running. The expedient universally adopted for reducing the frictional resistance in watches to the smallest possible amount, is the use of hardened pivots running in hardened steel steps, or in the finer timepieces, in steps made of rubies and sapphires. The development of the bicycle, which demonstrated the great saving in frictional resistance due to ball

bearings or roller bearings in many machines that at first might seem totally unadapted to their use, but to whatever use ball bearings may have been applied so far, none would seem as impracticable as their use in watches. That this difficult feat has been accomplished, however, we are assured by the evidence of a ball-bearing watch shown at the Paris Exposition, which is of ordinary size and has ball bearings throughout with the exception of the movable parts of the escapement. Two sizes of balls were used, one-fiftieth and one-hundredth of an inch in diameter. The balls were hardened, polished and necessarily well rounded, for without this feature of accuracy their use would have been worse than useless. Whether ball-bearing watches will come generally into use, we will not prophesy, but it is apparently not beyond possibility. The principal claim for superiority made for the use of ball bearings is that it allows of the use of larger pivots than are now used and thus the danger of breakage will be eliminated.

AMATEUR'S SHAPER.

The manufacture of tools for amateur mechanics is apparently quite an important industry in England, and at least one publication, the "English Mechanic," is principally devoted to amateur workshop practice and astronomy(!). It appears to be the proper caper with the Briton to make the tool or appliance that he desires, especially if he has considerable spare cash. It makes no difference whether it is a motor carriage or a telescope, the amateur tackles the job with the utmost confidence, and often succeeds in producing a very creditable piece of work. It is supposed that the actual cost is a minor consideration, and such is the case, many of these amateurs being wealthy men who employ their leisure in this way.



Hand Shaper.

The hand shaper shown in the accompanying sketch is made by a manufacturer of lathes, some very elaborate, for amateurs and also high-grade precision machinery for general workshops. The hand shaper weighs about 200 pounds and costs the purchaser about $60. It is recommended as being "a saver of time, files, and money," and as the latter consideration is mentioned, it must also be intended for the working artisan who uses his skill to procure his "daily bread and Sunday chicken," as well as for the man with means who likes to "tinker." The ram is operated on the push-and-pull principle by grasping the long handle at the right, and it is claimed that a cut of 3-16" (whatever that may mean) can be taken without undue fatigue. The ram traverses automatically, the feed mechanism being shown in the cut. Its capacity is 8" x 6" x 6".

HOT-BLAST HEATING.

In hot blast heating, the proportional heating surface is generally expressed in the number of net cubic feet in the building for each lineal foot of one inch steam pipe in the heater. On this basis, in factory practice, with all of the air taken from out-of-doors, there is generally allowed from 100 to 150 cubic feet of space per foot of pipe, according as exhaust or live steam is used, the term "live steam" being taken in its ordinary sense as indicating steam of about 80 pounds pressure. If practically all of the air is returned from the building, these figures will be raised to about 140 as the minimum, and possibly 200 cubic feet, as the maximum, per foot of pipe. Of course, the larger the building in cubic contents the less its wall and roof exposure per foot of cubic space, and consequently the less the loss of heat and the smaller the heater relatively to the cubic contents. In such buildings, used for manufacturing purposes, where the occupants are usually well scattered, an air change once in fifteen to twenty minutes represents the general practice; but in public and similar buildings this change is of necessity reduced to one in seven to twelve minutes. Owing to the increased loss of heat by leakage or ventilation under such conditions, and also to the demand for a slightly higher temperature than in the shop, the allowance is dropped to from 70 to 75 or 225 cubic feet of space per foot of pipe, for all of the air is taken from out-of-doors and low-pressure steam is usually employed. The great range in all of these figures must make evident the influence of the size, construction and uses of a building upon the size of the apparatus required, and show the necessity of extended experience for the proper designing of any system of heating and ventilation.—From Treatise on Ventilation and Heating, by B. F. Sturtevant Co., Boston, Mass.

THE BEST RECORD.

The Central Machine Engine Works, West Hartlepool, England, have installed propelling machinery in the steamers "Inchkeith" and "Inchdune" with which the consumption of coal has been less than a pound per horse power per hour. The following particulars of the engines are given in the *Scientific American*:

All the cylinders, with the exception of the high-pressure, are lined and jacketed, the last-named being unjacketed. The cylinders are completely surrounded by steam, all external surfaces being lagged. The expansion is quadruple, in five cylinders, two of which are low-pressure. The boilers are of the Scotch type, and carry a pressure of 267 pounds to the square inch. Above the boiler tubes at the front end is a superheater, and above this are nests of vertical pipes for heating the air on its way to the furnace. Special attention is paid to the feed-water, which is pumped first through a contact heater, then through a surface heater and is filtered before passing to the boilers. The feed-water which at the hot well has a temperature of 96½ degrees, leaves the contact heater at 370 degrees. The steam enters the superheater at 412 degrees and leaves it at 469½ degrees. In the tests the temperature of the air on the deck of the vessel was 53 degrees, and after leaving the heater it entered the furnace at 290 degrees. The temperature of the gases on leaving the boiler tubes was 587 degrees; this was lowered 44 degrees in the superheater, and 41 degrees in the air heating tubes. The hot gases are drawn through the air-heating tubes and delivered to the smokestack by means of a fan, and such is the saving of heat that their temperature at the fan discharge was lowered to 319 degrees F., that is to say, over 90 degrees below the temperature of the steam in the boilers.

This is the best performance that has been made on a commercial scale by any engines and boilers.

A SOLAR MOTOR.

The most celebrated attempt that has been made to operate a motor through the heat from the direct rays of the sun was that of John Ericsson. While his experiments were unsuccessful, others have been at work upon the problem and there is now operating at South Pasadena, Cal., a solar motor of 10 horse power that is said to give satisfactory results. Our information is derived from the *Los Angeles Times* kindly sent us by a subscriber, in which are half-tones from photographs of the motor and reflector as set up for operation. We have also favorable reports of the motor from other sources.

The reflector resembles a huge umbrella open and inverted at such an angle as to catch the sunshine on the hundreds of mirrors which comprise its inside surface and reflect the heat on the long slim boiler which takes the place of the umbrella handle. The machine is set in meridian on two fixed supports, so as to balance the entire frame, and rests on an equatorial mounting, like a telescope, the axis being due north and south, and the machine turning east and west in following the sun. The reflector is 33 feet 6 inches in diameter on top

and 15 feet on the bottom. It contains 1,788 mirrors about 3½ by 24 inches in size. The weight of the device is about 8,300 pounds.

The boiler is of tubular form, thirteen feet and six inches in length, with a capacity for 100 gallons of water and eight cubic feet additional steam space. The boiler is made of firebox steel, covered with an absorptive material, of which lampblack is one of the principal ingredients.

As the machine is disposed so as to automatically balance itself in any position, and is carried on roller bearings, very little power is required to turn it. Provision is made for varying wind pressures, and it is designed to withstand a gale of 100 miles an hour.

When the sun strikes the mirrors both heat and light are reflected to the boiler and there concentrated. Steam pressure is carried at 150 pounds. When power is desired, the reflector must be swung into focus, which is done by turning a crank. There is an indicator which readily shows when the true focus is obtained. This done, the reflector follows the sun closely all day, being regulated by a common clock. In about an hour the engine can be started.

The engine is of the compound type, and was built by W. D. Forbes & Co., Hoboken, N. J. It has been found by test to run on a very low steam consumption, as, of course, is necessary to make the whole apparatus efficient and of a reasonable size for a given power. It is connected with the boiler by a flexible metallic tube to avoid trouble from stuffing boxes. The balance of the machinery was built at Boston, and the whole apparatus is controlled by the Solar Motor Co., of that city.

It is claimed that the motor will operate in winter as well as in summer, the temperature of the atmosphere having but little effect upon its efficiency. It can be run from an hour and a half after sunrise to half an hour before sunset. It is at present engaged in running a centrifugal pump to pump water from an underground tank.

* * *

DIES FOR DRAWING WIRE—THEIR MANUFACTURE AND USE.

Wire drawing, as understood in the manufacturing world, is the art of reducing the diameter of metals by successive passages through holes of gradually decreasing size in plates called dies. This gradual decrease gives a corresponding increase in the length of the "wire," the actual ratio varying by a constant proportion depending upon the reduction in diameter. The holes in the dies are usually made to conform to one of the numerous wire gages, or to a system expressed in decimals, depending on the method employed in the mill where they are used. The variation or decrease in successive sizes, which is termed "drafting," is limited by the tensile strength of the metal, and also by the desired amount of hardness which is required in the finished article, and each wire drawer has his own ideas on the subject. On coarse sizes, say to No. 5 B. & S. Gauge, several numbers may be covered by each reduction. From these to about No. 40, one size at a time is usually reduced; and from thence the reduction is made by a difference of 1-1000 of an inch at a time, and by 1-10 of a thousandth, when a size nearing 1-1000-inch diameter is reached. These figures are, of course, dependent on the nature of the metal, and very often much less differences are required.

The dies, of course, are the all important factors for successful work. They must be of a substance which will not wear quickly or unevenly; they must be capable of severe usage; and lastly, they must be as inexpensive as it is possible to make them and still be durable.

Where great accuracy is required in the sizing of wire, the diamond is by far the best material for a die. It is the only substance which can be used for very fine sizes, and they are even used as coarse as No. 12 B. & S. Gauge. This seems to be rather a large size, but still the principal objection is the first cost, and as the nature of the material is brittle, many fear to use them for sizes heavier than No. 15. They are without question the most economical in the end, where large quantities of wire are drawn, and even when they become worn, may be reamed out considerably with comparatively small layout.

The substance used is the black diamond or "Bortz" which is found principally in South Africa and Brazil. It is extremely hard and the boring of the hole, a slow and tedious operation. Take the case of a piece about ⅛-inch thick. The spindle which does the drilling runs at a speed of about 5000 R. P. M., and, running ten hours a day, will require two to three weeks to get through that distance. When the drilling operation is completed, the stone is set in a brass plate about 1¼ inches diameter and ¼-inch thick, and stamped with the size, usually expressed in decimals of an inch, and the weight of the stone used.

In a comparative test made as to the relative hardness of common agate and diamond, a piece of the former about ½-inch thick was placed in the drilling machine and operated on in a similar manner. The drill went through that distance in seventeen minutes. Sapphires are also used for dies, and are hard enough for some purposes, while their comparatively low price makes them desirable in some cases; but where durability and accuracy are the prime features, the diamond stands alone as the best known substance.

For sizes down to ¾ of an inch diameter, a tool steel plate with a hole in it of the required size is generally used. If the object is merely to quickly reduce the diameter, this hole does not require accuracy; but if the work is to be finished on that size, it should be carefully polished, as every nick will show a scratch on the work.

Dies made of chilled iron are usually employed for sizes below ¾-inch down to about No. 10 B. & S. Gauge, and are made from close-grain iron, being cast in a cast-iron mould or "chill," which makes them very hard and dense. The holes are cast conical in form, the large end being at the back where the wire enters. These holes, however, do not usually extend clear through, a thin wall of metal being left on the small end to be punched out and finally reamed to the required size. This reaming is done by means of a steel drill of square section revolving at a slow speed, giving a finished hole of constant size, ranging from about 1-16 to 3-16 of an inch long, depending on the size. These chilled iron dies are usually made with four to eight holes each, about 1¼ inches apart; the thickness of the die varying from 1 inch to 1½ inches, and the length according to the number of holes cast. They are inexpensive at first cost, and, when worn, may be reamed out to larger sizes without impairing their usefulness. Hundreds are used in every mill, and their manufacture is an art by itself.

Steel dies are also used in large quantities, for sizes ranging from No. 10 to No. 18. They are made of high grade tool steel, either from round rods with a single hole, or rectangular bars with several. These holes are of conical form also, with the small end reamed to size, and may be used indefinitely. The steel is not hardened, so that when the hole becomes enlarged by use, the front of the die is hammered or "upset," and the hole again reamed out, the operation being done by hand with tools of the required size.—W. D. Pierson, in "Stevens' Indicator."

* * *

Prof. Elisha Gray, who died the latter part of January, had recently been experimenting with a system of transmitting signals to vessels by means of a submerged bell. A bell weighing 800 pounds and submerged to a depth of 20 feet was found to sound audible signals to a vessel one mile or more away, irrespective of the state of weather and without any special receiving apparatus. The sound traveled through the water and reverberated in the hold of the vessel. A submerged ear trumpet with a diaphragm sealed over the mouth and connected at the other end to a gas pipe leading through the side of the vessel enabled the signals to be distinctly heard three miles away. A special electrical device increased the audible range to twelve miles.

Prof. Gray's career was a remarkable one, beginning as it did in the blacksmith shop and in work as a carpenter and boat builder. He shares with Prof. Bell the credit of the invention of the telephone, although the courts have decided that Prof. Bell is the rightful inventor from a legal standpoint. It was held, that Bell's patent was applied for a few hours earlier than Gray's and therefore the former received the patent. There is no question, however, but that both have done original and remarkable work in developing the telephone.

Entered at the Post-Office in New York City as Second-class Mail Matter.

MACHINERY

A practical journal for Machinists and Engineers, and for all who are interested in Machinery,

PUBLISHED MONTHLY BY

THE INDUSTRIAL PRESS,

9-15 MURRAY STREET, NEW YORK CITY.

ONE DOLLAR A YEAR, POSTAGE PREPAID, TEN CENTS A COPY.

FOREIGN SUBSCRIPTIONS ONE DOLLAR AND FIFTY CENTS A YEAR.

Lester G. French, Editor.
Fred E. Rogers, Associate Editor.

The receipt of a subscription is acknowledged by sending the current issue. Remittances should be made to THE INDUSTRIAL PRESS, and not to the Editors. Money enclosed in letters is at the risk of the sender. Changes of address must reach us by the 15th to take effect on the following month; give old address as well as new. Domestic trade is supplied by the American News Company or its branches.

We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

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TURKEY.—Constantinople: V. L. Levy.
UNITED KINGDOM.—Sampson Low, Marston & Co., St. Dunstan's House, Fleet Street, London, E.C.

MARCH, 1901.

CIRCULATION STATEMENT.

MACHINERY has the largest paid circulation in its field in the world. It reaches all classes—journeymen, foremen, draftsmen, superintendents, employers; and covers the machinery field thoroughly. The regular editions of MACHINERY for the past twelve months are given below, and any advertiser in the paper will be afforded every facility to verify the correctness of these figures:

1900.		1900.		1901.	
April	21,500	September	21,750	January	27,500
May	21,500	October	24,000	February	26,500
June	27,500	November	25,000	March	30,000
July	22,000	December	27,500		
August	21,500				

We have recently established three branch offices for the advertising and subscription work on MACHINERY. Chicago, 1505 Manhattan Building—R. A. Evans, Manager; Fred T. Dean, Circulation Manager. Boston, 620 Atlantic Ave.—H. L. Brown, Manager; H. N. Dinsmore, Circulation Manager. Philadelphia, Machinery Floor, the Bourse—T. G. Newbery, Manager; C. E. Jameson, Circulation Manager.

* * *

A contributor to our mining contemporary, *Mines and Minerals*, alludes to the mistaken secretive policy adopted by so many technical men in regard to their work and experience. The editor comments further on this and what he says is as true in mechanical work as in metallurgy. He suggests that while a desire to be secretive exists in many cases "with many men in practice it is not so much a desire to withhold information, as it is a real, or apparent, lack of time, or rather lack of inclination. Many feel that they cannot express their ideas on paper with the same ease and skill with which they run a mill or mine, or with the fluency or grace of a Longfellow or Holmes. It is very fortunate that this is true, else the mining fraternity would be robbed of its best talent for the benefit of the literary world. Every man in practice can tell what he is doing or has done, and it is the business of the technical editor to do the polishing and finishing, and he will always attempt to clothe interesting facts in proper dress for presentation to the public, who, after all, are not nearly so critical of how a thing is said as of what is said."

* * *

KEEPING EVERLASTINGLY AT IT.

This number of MACHINERY is not a "special" nor an "annual," and no unusual effort has been made to obtain advertising therefor, although it happens that the edition is 30,000 copies, the largest number ever printed by a paper in its field, and more than double that of any competitor. The growth of MACHINERY in a little more than six years is an example of what can be accomplished, when a demand actually exists, by systematic and unceasing work; and as such may interest some of our readers. The steady growth of subscriptions, and especially the heavy increases during the past year, a few of which are given below, show not only the results from work of that kind, but also indicate that MACHINERY contains the kind of information its readers want; for unless this were true, no amount of work would permanently increase its circulation.

	1899.	1900.
Edward P. Allis Co., Milwaukee, Wis.	79	100
Betts Machine Co., Wilmington, Del.	27	47
Billings & Spencer Co., Hartford, Conn.	50	103
Booth-Lloyd Co., Youngstown, Ohio	15	34
Brown Hoisting & Conveying Co., Cleveland, Ohio	78	144
Brown Cotton Gin Co., New London, Conn.	6	30
Brown & Sharpe Mfg. Co., Providence, R. I.	193	521
Buckeye Engine Co., Salem, Ohio	37	44
Cambria Iron Co., Johnstown, Pa.	25	34
Carnegie Steel Co., Pittsburg, Pa.	29	34
Davis & Furber, North Andover, Mass.	13	27
Dempster Mill Mfg. Co., Beatrice, Neb.	15	31
Erie Railroad Shops, Meadville, Pa.	5	36
E. & F. Fairbanks Co., St. Johnsbury, Vt.	13	29
Harrisburg F. & M. Co., Harrisburg, Pa.	17	30
Hendey Machine Co., Torrington, Conn.	18	70
Juniata Shops, Pa. R. R., Altoona, Pa.	6	56
Lowell Machine Shops, Lowell, Mass.	12	38
Lozier Bicycle Co., Toledo, Ohio	3	52
W. B. Mershon Co., Saginaw, Mich.	15	27
J. H. McEwen Co., Ridgeway, Pa.	11	36
Morse Twist Drill and Machine Works, New Bedford, Mass.	14	111
Pratt Institute, Brooklyn, N. Y.	30	50
F. E. Reed Co., Worcester, Mass.	13	57
Risdon Iron & Loco. Wks., San Francisco, Cal.	27	45
Rock Island Arsenal, Rock Island, Ill.	34	92
Bethlehem Steel Co., South Bethlehem, Pa.	12	218
E. S. Stacey, Springfield, Mass.	16	29
Stanley Electric Co., Pittsfield, Mass.	29	51
Twin City Iron Co., Minneapolis, Minn.	8	33
Union Iron Works, San Francisco, Cal.	29	145
Vermont Farm Machine Co., Rockingham, Vt.	9	35
Waltham Mfg. Co., Waltham, Mass.	17	27
Waterbury Farrel Foundry and Machine Co., Waterbury, Conn.	3	53
Westinghouse Mach. Co., East Pittsburg, Pa.	105	253
Warder, Bushnell & Glessner Co., Springfield, O.	15	60
Wilson-Snyder Mfg. Co., Pittsburg, Pa.	23	44

The impression which has been industriously circulated that MACHINERY is a paper for "shop men" *only*, is not borne out by an examination of our circulation data, which show that a greater proportion of employers, superintendents, draftsmen and foremen read MACHINERY than any other mechanical paper. Our subscription list includes a large percentage of all the intelligent men in the works, and it is self evident that the subscriptions which come first and easiest are from those who are earning the most money.

The obtaining of subscriptions to a trade paper is vastly different work from that of a daily where its possible readers are massed by the hundred thousand in populous centers, and has become increasingly difficult during the past ten years. Yet it is the most necessary part of the publisher's work, for without a substantial list of paying readers no paper can hold its advertisers, from which the major portion of the revenue comes; and although we have built up the best subscription organization possessed by any trade paper we do not intend to rely on that alone, for we fully appreciate that we shall continue to obtain success only as we merit it.

NOTES AND COMMENT.

The New York Shipbuilding Company, of Camden, N. J., was recently awarded the contract for building four large steamships for freight and passenger service for the Atlantic Transport Company. Two of the vessels are to be 600 feet long each and of 12,000 tons carrying capacity. The other two are to be somewhat shorter. The cost of the four vessels is said to be $5,000,000. They will be four of the finest and fastest vessels in the Transatlantic trade.

The South Carolina Interstate and West Indian Exposition, at Charlestown, S. C., will open on December 1, 1902. It is international in character, and the resources of the West Indies and the Central American countries will be exhibited. Mr. Bradford L. Gilbert, New York city, is the architect of the Exposition. There will be eleven buildings in all, the largest of these to be devoted to commercial, agricultural and textile exhibits. There will also be every facility and accommodation for the exhibition of machinery.

Chief Engineer Melville, in his annual report to the Secretary of the Navy, asks that a repair ship similar to the Vulcan be built specially for the purpose. The vessel is required to have high between-decks and moderate protection and armament, which, while not rendering it invulnerable, would promote the safety of the men and machinery during the dangers of a naval war. A vessel of this character which would meet the requirements is thought to have a displacement of about five thousand tons, and to cost, complete, about $1,000,000.

Since the construction of the famous little Turbinia, two 380-ton vessels have been constructed with steam turbines as propelling power. Now a still larger vessel with the same kind of propelling power is projected to run on the Firth of Clyde. The vessel is to be 250 feet in length, 30 feet in beam, and 11 feet in molded depth, and is to attain a speed of 20 knots with turbine engines of 3,500 to 4,000 horse power. Power will be developed on three shafts, by a compound turbine; one high pressure on the center shaft, and two low pressure turbines on the side shaft.

The United States Navy is at present furnishing a market for some of the old engine lathes in the various navy yards. While all new war vessels are equipped with a small machine shop containing new modern tools, the older vessels are in some cases provided with old tools that have been in service in some of the navy yards. It is usually the case that limited shop room on board ship requires that the lathe shall not have a length of bed over six or seven feet, giving a swing of three or four feet between centers, so the old bed and lead screw will be cut off to the allowable length and the legs moved along and secured, thus making a handy lathe of short swing. The room is so restricted that often when the machine is in position there is barely space to remove the change gears at the end.

The new East River bridge that is being constructed between the boroughs of Manhattan and Brooklyn, New York, has so far been completed that work is now beginning on the central span. The distance between the two towers that support the cables for the span is 1,600 feet, the same as in the original Brooklyn Bridge. There will be four main cables, 18¼ inches in diameter. Each of these will consist of thirty-seven strands, and will have no fewer than 10,434 wires and a strength of 40,000,000 pounds. They are of the same diameter as those of the older structure, but are much stronger, owing to improved material.

The greatest care in the manufacture and putting into place of these cables is taken, for upon the perfect construction of these depends the safety of those who use the bridge. The work on this bridge will proceed at a rate twice that of the Brooklyn Bridge, inasmuch as the cables will be put into place from both sides of the river instead of but one. It will take probably three years to complete the suspension portion, and probably considerably more time in which to perfect the purchase of lands and putting into condition of the approaches.

TRANSPORTATION OF AUTOMOBILES.

The Law Committee of the Automobile Club of America, with headquarters at the Waldorf-Astoria, New York, have issued a circular calling attention to a bill recently introduced in Congress to amend the law with regard to the carriage by steam vessels of motor vehicles using gasoline. As we have previously mentioned, the law is such as to practically prohibit automobilists crossing any body of water by ferryboats or steam vessels without completely discharging the gasoline contained in their vehicles and trusting to luck to get a fresh supply after leaving the vessel. This has interfered with the pleasures of using an automobile and has injured the automobile trade to a greater or less extent.

Some provision should be made for the carriage of automobiles by water. Motor vehicles are here to stay and the times demand that there should be no unreasonable restrictions to their use. In a locality like New York, where the outlets of travel are by ferry in every direction but one, the present law is an undoubted barrier to the use of automobiles. In our opinion, however, the automobile club are attempting the reform in the wrong way. They have the problem by the wrong handle and, as is too often the case, by the handle which will enable them to manipulate it the easiest rather than the most effectively. Any relaxation of a law that would add to the possibility of a conflagration upon a crowded ferry-boat is clearly not in the interests of public safety. The first move in justice to the public should be to exert strenuous efforts to compel ferry companies to make the central passage-ways of their boats, in which vehicles of all kinds are carried, as nearly fireproof as possible. When this is accomplished it will be in order to allow gasoline to be carried upon a crowded boat. Until this is done, it might not be impracticable to have discharging and filling tanks for gasoline in charge of the employees at the more important ferries. They would add to the convenience of automobilists without adding to public danger.

USE OF THICK BOILER PLATES.

Considerable comment has been caused by a recent report rendered to the Mutual Boiler Insurance Co., Boston, by their consulting engineer, R. S. Hale. For many years engineers have condemned the use of thick boiler plate where it comes in contact with the intense heat of a boiler furnace. Mr. Hale now upholds, and it is stated that his company will insure, return tubular boilers with shell plates 9-16 inch thick. Such plates, with quadruple-riveted joints, will permit 170 pounds pressure to be carried on a 72-in. boiler with a factor of safety of 5, or 135 pounds pressure on a 90-in. boiler. He estimates the cost of a 90-in. boiler complete with setting at $2,000, and shows that with a rating of 400 horse power this cost is only $5 per horse power, the larger the boiler the smaller being the cost per horse power.

The reason for limiting the thickness of shell plates in the past has been the theory that a thicker plate offered more resistance to the transmission of heat and rendered the plate more liable to overheating. Mr. Hale contends that this is erroneous, and computes that a plate 1 inch thick, transmitting heat so rapidly as to evaporate 50 pounds of water per hour from and at 212 degrees, will have a difference of temperature between its two sides of only 168 degrees. Assuming, then, a steam pressure of 150 pounds, corresponding to a steam temperature of 365 degrees, Mr. Hale concludes that the temperature of the fire side of the plate will be only $365° + 168° = 537°$.

In referring to this the *Engineering News* points out that while Mr. Hale's argument is correct, he has overlooked the fact that the temperature of the water side of a plate is likely to be higher than of the water in contact with it, unless there is a rapid circulation of the water. Thus, it makes little difference what the circulation is around the smoke-box end of locomotive boiler tubes, whereas even with the best of care the tubes near the fire-box end gradually become overheated and burned away. It is also pointed out that as we increase the difference between the fire and water sides of the plate we are increasing the temperature stresses and setting up various internal strains tending to deform the boiler shell and to hasten corrosion by grooving.

FACTORY PHOTOGRAPHY.

PRACTICAL HINTS FOR THE SHOP PHOTOGRAPHER.

C. A. MERA.

A few years ago a photographic outfit was added to our drafting office equipment, and it has fallen to the lot of the writer to do most of the operating, although he was then, as now, only an amateur.

I venture to contribute the following in the hope that some one may be benefited thereby, since experience has taught me a few tricks which if I had known at first would have spared me much annoyance and saved my employers much time and expense.

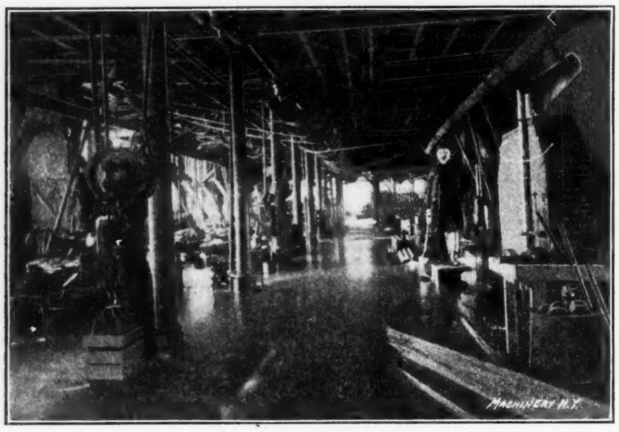


Fig. 1. Photographic Record of High Water.

We find new uses for the camera every day; it is an unimpeachable recorder of changes in the manufacturing plant or of improvements in shop methods. The scene of every accident is photographed as soon as possible after the mishap occurs. Floods, fires and strikes can be recorded with an accuracy too great to be questioned. When building a new machine for a customer some distance away it is convenient to be able to furnish him with a record of progress from time to time or perhaps to show up some "snag" or interference which may have been run into. Or, in erecting work away from the factory, a photograph sent home tells better than words the conditions that have to be met and how difficulties are overcome. It is not, however, for these unusual occasions that a manufactory should maintain a photograph department, but rather for the photographing of the regular factory products. If these are of convenient size, so that they may be arranged under a skylight or in a room where the light may be controlled by the operator, no great difficulty will be experienced. I have found it a good plan to stand such objects upon a large piece of unbleached cotton cloth so that the same piece may be drawn up behind for a background, thus avoiding any break where the floor leaves off and the back begins. If possible, the object should be painted in medium lead color, so mixed as to dry "flat," i. e., without gloss. Varnish is the photographer's abomination. It magnifies and exaggerates all the sand marks and rough spots on castings, and even though the work be machined and surfaced it will show up worse if varnished than without gloss. Where the gloss exists it may be deadened sufficiently by dabbing the glistening portion with a ball of moist putty, which will not affect the polish or the varnish, provided it is wiped off before it has time to dry. Sometimes it is desirable to show both the inside and the outside of a machine in one view to illustrate the relation of the various parts. This apparently difficult feat is easily possible by photography, as shown in Fig. 4. In this instance the scale was photographed twice on the same plate. The first time the complete object was exposed about half the usual length of time, then the lens was closed, the front plate of the machine was removed and another

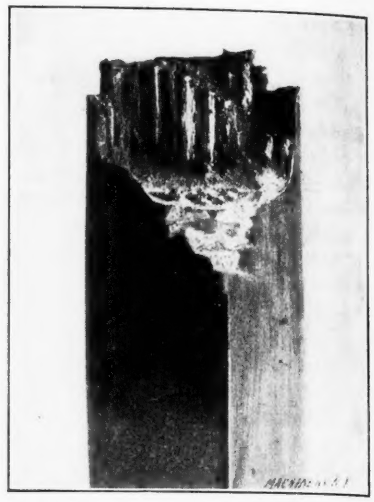


Fig. 3. Steel Pivot broken to show texture—the hard, white fracture being the working edge, and the long, tough fiber the body of the pivot.

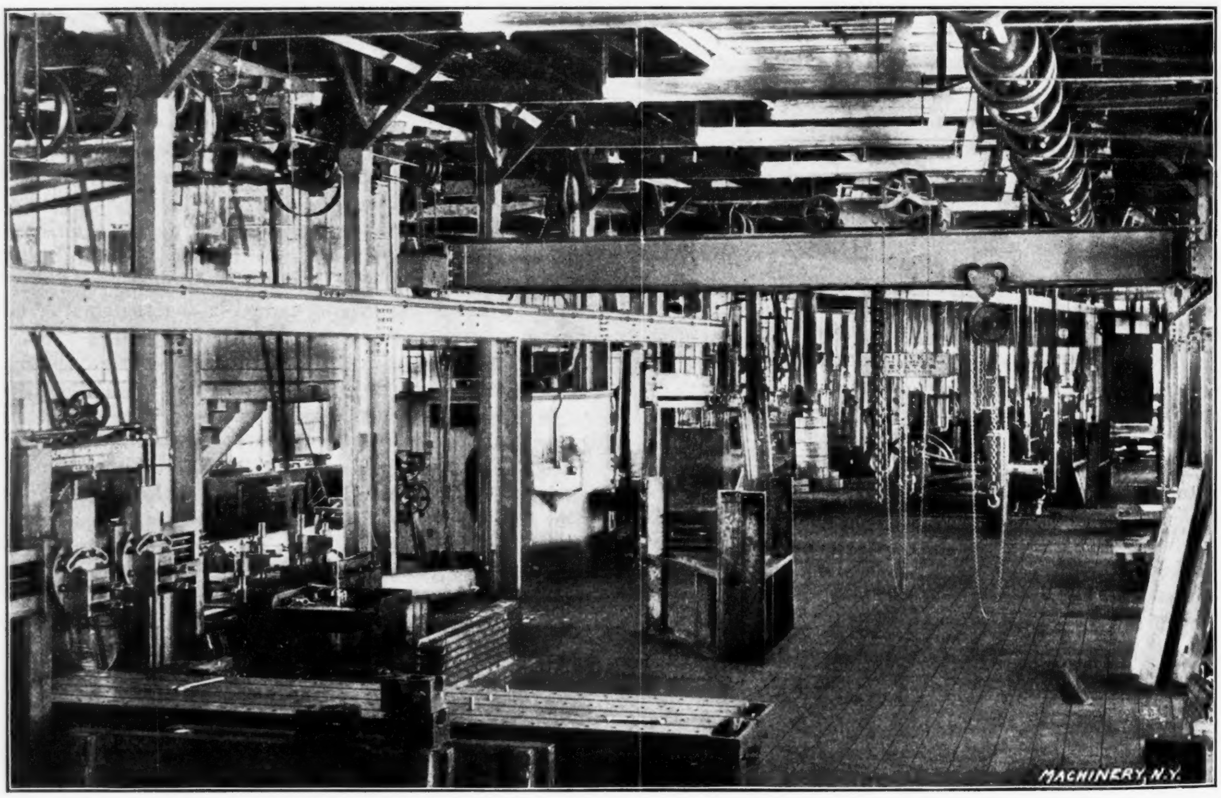


Fig. 2. Fairbanks Machine Shop, St. Johnsbury, Vt. Taken with workmen passing and machinery running.

exposure was made showing the interior parts. This exposure was rather more than half the usual time, as the interior was darker than the exterior, but the idea is to make the sum of the two (or more) exposures equal the usual time given to a subject under these conditions of light. Care must be taken, of course, not to move either the camera or the subject as it is necessary to have the second exposure superimposed on the first. In this way the outside case appears to be of glass, showing the works as it would if transparent.

Sometimes it is desirable to see how a machine would look if reversed or "left-handed." This is easily accomplished by putting a plate in the holder with the glass side out. Care must be taken that the glass is clean, which is not always the case, as this usually makes no difference. The development may be judged by looking through rather than at the plate.

In making tests of steel or iron by breaking specimens on a testing machine, photographs of the fracture are valuable since they describe the condition of the metal in a way which language cannot express. These views may be made larger than natural size without the use of a microscope by using a short focus lens and a long bellows on the camera; in which case they will be enlarged as many diameters as the focus of the lens is contained in the length of the bellows.

There are many cases where pictures must be taken in a dark shop, in restricted conditions, against the light, and where no special preparations can be made. In such cases one must do the best he can. Non-halation plates will somewhat prevent the parts being blurred which stand out against a strong light; but a better way is to cut off the light by screens of cloth or paper, which being kept in motion during the exposure will be softly blended so that it does not matter if they are creased or soiled. These screens may darken the picture, but this is no serious disadvantage, since flashlight powder may be touched off so as to light up the particularly dark parts; but best and easiest of all, a long exposure may be given. It is wonderful how much the lens will pick up that is practically invisible to the eye, provided long enough

Fig. 4. Photographed by two exposures, thus giving the effect of transparency to the front plate.

time is given it to do its work. Fig. 2, the photograph of a machine shop, was made under a dim light. An exposure of twenty minutes was given, using a quick plate and a medium stop. It was taken with the machinery in motion, as will be seen by examining the main line of shafting. The belts show a little hazy, and only the hubs and rims of the pulleys can be seen since the spokes were revolving rapidly. About eighty men work in this room, and many of them were passing and repassing while the picture was being taken. The chains on the traveling crane were several times set swinging, and once a truck load of stuff was drawn up into the

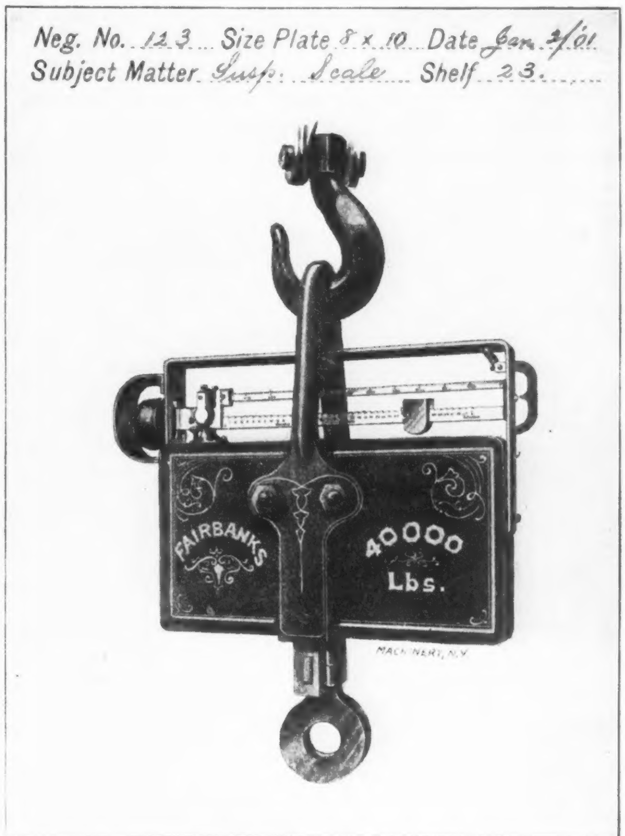


Fig. 5. Card Index for Photographs.

center of the picture and left standing so long that I was afraid it would show and drew it off into one of the side aisles. As none of these things show in the print it might be inferred that the camera was endowed with the faculty of selection, taking what was desired and leaving out all of the rest, but this is not so. The camera is like the old clown's trained donkey, "I haf only to tell it vat to do and it does shust vat it pleases." In this instance the exposure was so long that passing objects made relatively little impression on the plate—too little to show in the print. It will also be noticed that no blur is visible around any of the windows, this being due to the use of non-halation plates. Thus it will be seen that good results are not due to any especial skill on the part of the operator, but rather to the judicious use of good appliances.

For indexing negatives we use a card system, cutting the card a little larger than the largest plate. There is a heading printed across the top, and a space below on which is pasted a print from the negative so that one can tell at once not only where the plate may be found but also what it actually shows. Very many times it is not necessary to find the glass plate itself, a glance at the card being all that is necessary. These cards are stood on end in a box so that they may be referred to in exactly the same manner as the usual card index.

Ruskin says, "Every man should have a trade and a hobby," and almost every shop has a number of handy amateur photographers who have taken up this art as an amusement outside of their work, and some of these could doubtless turn their hobby into a trade to their own profit and their employer's benefit.

* * *

Four hundred years ago the Iberian peninsula was the abode of the highest civilization of Europe. In 1492 Columbus sailed from Spain and discovered the new world of America. Now American street car builders are shipping electric street cars and equipment to Lisbon, Portugal. The whirligig of time has brought about a condition of affairs that is truly wonderful.

MACHINE TOOLS, THEIR CONSTRUCTION AND MANIPULATION.—17.

EXAMPLES OF MILLING.

W. H. Vandervoort.

The smaller milling cutters which are carried on an arbor are usually driven by the friction between their faces and the arbor collars. They should therefore be rotated in the direction which tends to tighten the arbor nut. With the large cutters which are keyed to the arbor the direction of rotation may be either way. For a given rotation of the cutter the direction of the feed should be such as to force feed is as shown at *B*. The keen edge of the cutter lasts much longer with the feed in the direction indicated at *A*. The under feed indicated at *B* has been advocated by some, but is generally considered as incorrect, as the wear on the cutter and the danger of accident from the work drawing under is much greater. With milling machines using the rack feed when the work table is held only when the feed is in, the most careful workman will sometimes get into trouble if the under feed *B* is used.

When the cutter is operating on the end of the work as shown at *D*, the feed should be up, as indicated by the arrow; if the work was on the other side of the cutter, the feed should be down. In this class of milling it is best to feed up,

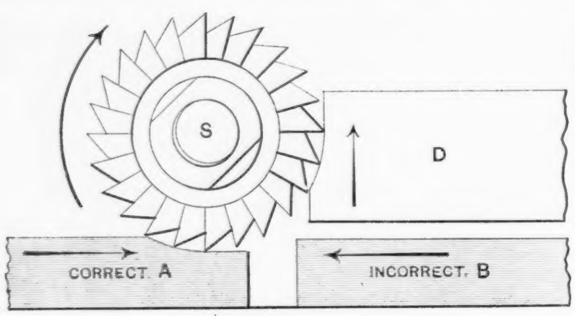


Fig.151

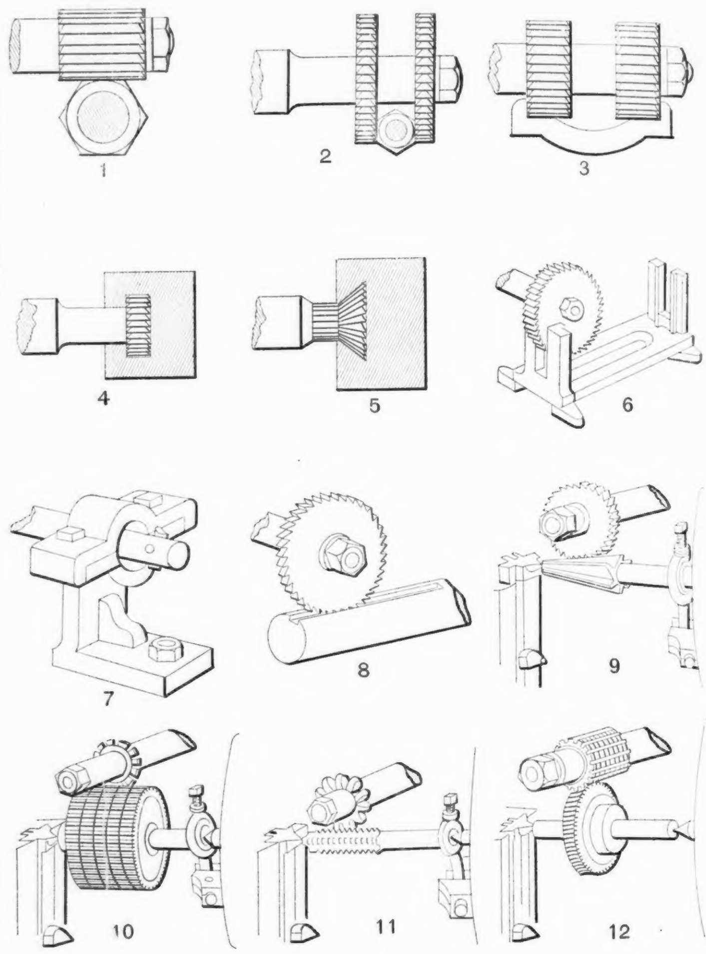


Fig.153

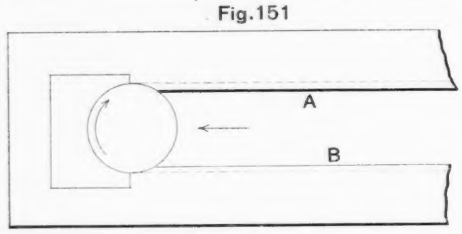


Fig.152

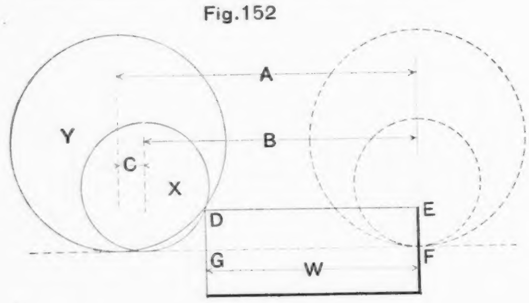


Fig.154

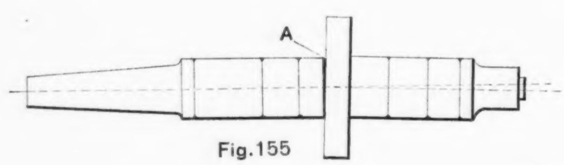


Fig.155

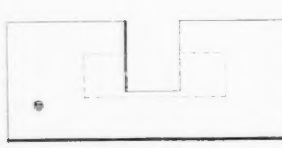


Fig.156

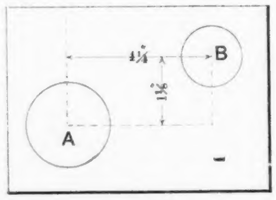


Fig.157

Fig.158

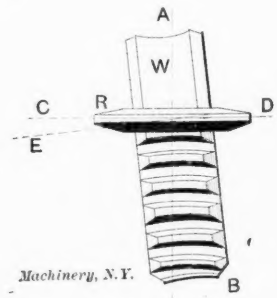


Fig.159

Examples of Milling.

the work against the cutter as shown at *A*, Fig. 151. When the rotation and feed are as above indicated, all slack or back lash between the nut and feed screw is taken up and the work is forced steadily to its cut. If the feed is as shown at *B*, the cutter tends to drag the work under it and as a result any slack whatever allows the work to move forward with an unsteady, irregular motion as the feed screw rotates. When the feed is as shown at *A*, the cutter teeth work from the bottom up, lifting the hard scale of castings and forgings rather than cutting down upon it, as is the case when the as that brings the pressure of the cut down upon the table and tends to close the joints of the table, saddle and knee, making the cut smooth and steady. When the table is to be fed vertically for work as shown at *D*, the table stops, provided with all milling machines, should be used and thus prevent any possibility of the work moving in or away from the cutter when correctly set. When it is necessary to use both sides of the cutter at the same time, as in Fig. 152, the direction of the feed should be determined from a consideration of the amount of stock to be removed from the sides. If the rotation of the cutter is as indicated and the most stock is to be removed from the surface *A*, then the feed

The illustrations in this article are in part from the catalogues of the Brown & Sharpe Mfg. Co. and the Cincinnati Milling Machine Co.—Editor.

should be in the direction shown by the arrow. The cut on the upper surface then tends to retard the feed and the cut on the lower surface to draw the feed, and since the cut on the upper surface is heavier than that on the lower, the retarding pressure is greater than the drawing, and a smooth, steady cut results, with a minimum danger of injury to the work and cutter. If the cut was heaviest at the surface *B*, the cutter should be started from the opposite end and the direction of the feed reversed.

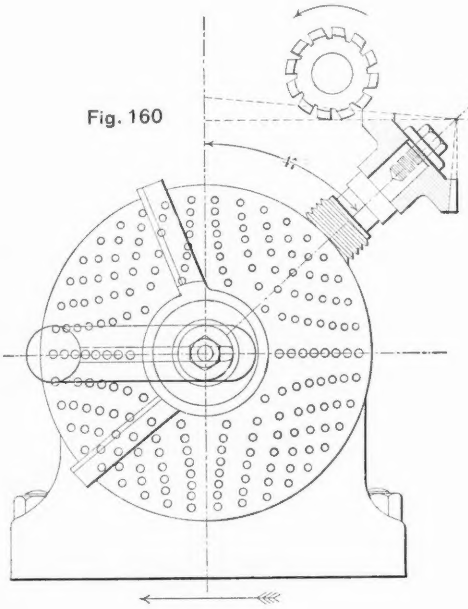
Plain surfaces may usually be milled either by the plain axial milling cutter or a radial or end mill. The axial cutter leaves a smoother surface and is more easily kept in order than the radial. The tendency to spring and distort the work is, however, greater with the axial cutter as the pressure of the cut is very largely at right angles to the work surface while with the end mill the pressure is almost wholly in the direction of the feed. The character of the work usually determines which class of cutter to use. At 1 and 2, Fig. 153, are shown two ways of milling a common hexagon nut. The straddle mills of No. 2 are radial cutters and, as arranged, finish two surfaces each time over the work. An end mill might be used, in which case but one surface would be finished at a time. In any case the diameter of the mill should be as small as strength and convenience will permit. An inspection of Fig. 154 shows the reason for this. If the portion *D E F G* of the work is to be removed by the cutter, it is evident that the smaller cutter *X* will travel the distance *B* in completing the cut, while the cutter *Y* must travel the distance *A*. If the width *W* of the work is small, the saving in time required for the work by using the small cutter becomes a considerable portion of the total time. The first cost of the smaller cutter is less and the power required to drive it also less than with the large cutter.

In placing cutters on the arbor, the faces of the cutter and the arbor collars should be carefully wiped and thus insure a true running cutter. As shown in Fig. 155, a small piece of cutting or dirt (*a*) between the faces, causes a spring in the arbor and the cutter will run out of true. When made, the faces of these collars are carefully brought parallel with each other and, with reasonable care, they can be kept in this condition. When, as in 2 and 3, Fig. 153, two cutters are to be used for straddle work, it is necessary when the distance between the faces of the work is to be of exact dimension, to have collars of suitable length. As the regular collars usually make up by eighths above one-fourth inch, suitable washers must be provided for making up the exact dimension. These may be had with parallel faces and varying in thickness by .001″, thus making it possible to obtain any desired dimension between the faces of the cutters. When it is required to machine the top surface of the work, a plain axial cutter can be used between the straddle mills in place of the collars and washers.

At 4, Fig. 153, is shown the final operation in the milling of a T-slot. The neck of the slot and all the metal possible should be first removed with a plain axial cutter, as in Fig. 156, which leaves a minimum amount of work for the more delicate T-slot cutter to perform. If the nature of the work is such that a plain cutter cannot be used, the stock can be removed with an end mill. In this case, a cutter somewhat smaller in diameter than the required width of the neck must be used first, as the spring of so small a cutter when taking such a heavy cut would cause the work to be untrue. The neck can then be finished to exact width by passing a sizing cutter through or by trimming each side with a finishing cut with the roughing cutter. The milling of a V-slot, 5, Fig. 153, is similar to that of the T-slot, the most of the stock preferably being first removed with a plain cutter or an end mill. The cutter shown could be used to complete the work at once, without the use of a stocking cutter as it is provided with teeth on its shank. This is not, however, the customary method, as the necks of these cutters are not usually provided with teeth and the spring of the cutter makes smooth, accurate results very hard to obtain.

At 6, Fig. 153, is illustrated a method of milling the guides of a housing. With a cutter of proper thickness and diameter, both sides and bottom of the guides are finished at one cut. This figure serves to suggest one of many similar operations that can be performed with a plain cutter. No. 7, Fig. 153, shows how the milling machine can be used for boring and facing work. The work is clamped to the table of the machine and a short boring bar placed in the spindle bearing. If the hole to be bored is of considerable length and diameter, the outer end of the bar should be formed to fit the bearing of the overhanging arm, thus making it firm and capable of producing a smooth, true bore. An automatic in-and-out feed is very desirable for work of this character. It will also be noted that the vertical and lateral adjustments to the work table enable the work to be set in any desired position for the boring of parallel holes. Take, for example, the piece of work shown in Fig. 157, where the two holes are to be bored parallel with each other. The work should be first squared up and the hole *A* bored; after which, by means of the graduated elevating screw, the work can be dropped exactly 1⅛″ and by means of the graduated feed screw set over the 4¼″, which brings the center of the hole *B* into exactly the proper position for boring. In like manner any desired number of settings may be obtained quickly and with great accuracy. In making setting measurements by the use of the graduated screws precaution must be taken to avoid the error that might arise from neglecting to consider the

Fig. 160



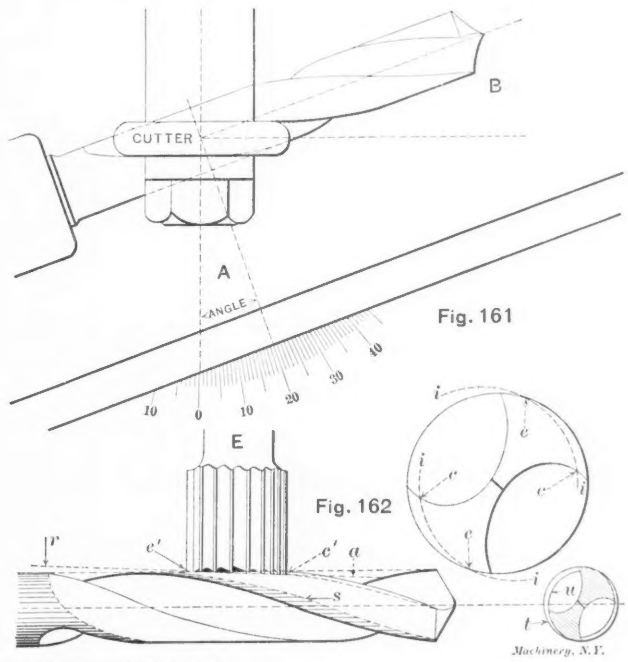


Fig. 161

Fig. 162

Cutting Bevel Gears and Fluting Twist Drills.

back lash between the screw and its nut. Thus, if a vertical adjustment is to be made, the table for the first operation should be dropped a little too low and brought up to the proper point. The index can then be set at zero and the work table raised the exact amount required by the graduated screw. If by accident the table is raised too high, it should be lowered somewhat below the proper point and again brought up to the correct reading. This insures against any error arising from the back lash and means that in all settings the slack between the nut and screw should be kept on the same side.

A long tool with cutting edge at right angles to the boring bar may be used for facing off the end of the work after the boring operation. The end next to the spindle can, of course, be faced with an end mill if desired, or a facing attachment consisting of a slide and tool-carrying head can be mounted for this purpose on the nose of the spindle or on the boring bar. Twist drills and reamers mounted in the spindle of the milling machine can frequently be used to very good advantage on many classes of work.

No. 8, Fig. 153, shows the method of keyseating a shaft in the milling machine. Where the keyway is not cut the entire length of the work, a rounded end is left, which is usually not objectionable. If a cutter of small diameter is used the length of the rounded end is not great. In cases where the keyway must be full depth to the end, an end mill of diameter equal to the width of the keyway can be used to finish out the rounded end. By placing several shafts together on the table and putting as many cutters on the arbor, properly spaced, all keyways may be cut at one operation. This is advantageous where a large number are to be cut at one setting of the machine. When a keyway is to be cut in the shaft at some point between the ends, to receive a short key or feather, the end mill is used. If the mill is not of the center-cut type a small hole, a little larger than the diameter of the toothless center of the cutter, should be drilled at one end and to a depth equal to the depth of the required keyway. This allows the mill to cut its way to the bottom and then feed out. For this work the cutter should run at a comparatively high rotative speed and should be given a fine feed, as otherwise the spring is excessive and the work untrue.

No. 9, Fig. 153, shows the method of fluting a tap or reamer. The present example is that of a taper reamer. In this case the tail center is raised an amount sufficient to give the proper depth of cut at each end of the flutes. The cutters usually employed for this work are specially formed cutters and should be set so that the face of the cutter that cuts the front face of the tooth stands on a radial line with the blank being fluted, as shown in Fig. 158.

No. 10, Fig. 153, shows the method of cutting spur gears in the plain or universal milling machine. One or more of the gear blanks is mounted on a mandrel and placed between the centers, the gear cutter having been previously placed on the arbor and the table adjusted in and out so the center of the cutter falls in the line of the work centers. The index is set to give the correct number of divisions and the work elevated until the rotating cutter just touches the rim of the gear blank. The graduated dial on the elevating screw is then set to zero, the work moved out from under the cutter and raised an amount equal to the required depth of the tooth. Spur gears too large to swing between centers can often be cut by placing the index head spindle in a vertical position and carrying the blank on a vertical mandrel held in the spindle. This places the blank in a horizontal plane and the cutter is set to depth by the table feed screw and the work fed to the cutter by the vertical feed.

The fluting of the tap shown at No. 11 is similar in all respects to the fluting of the reamer in No. 9. No. 12 shows the method of hobbing a worm gear, the blank having been previously gashed. The hob is a cutter of exactly the same shape as the worm that is to mesh with the gear and simply forms out the teeth, the blank rotating free on the centers. In gashing the teeth of the worm gear before hobbing, it is placed on the mandrel between centers and the index set for the proper number of teeth. A gear cutter of suitable size to remove most of the stock, leaving only enough for the hob to finish, is placed on the arbor and brought central with the work. It is then necessary to swivel the table an amount *C D E*, Fig. 159, depending upon the pitch and diameter of the worm. The work is thus raised to the cutter the proper amount and dropped for each succeeding cut. If the thread

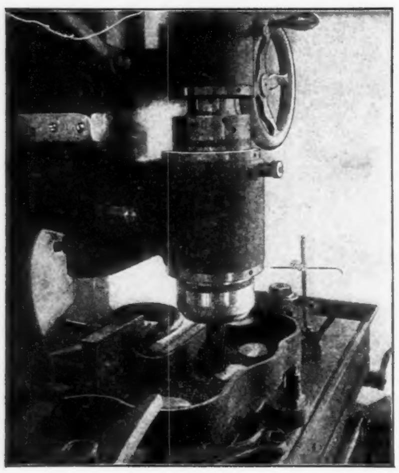


Fig. 163.

Fig. 164.

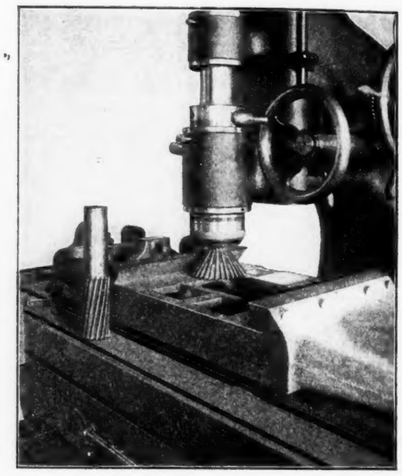


Fig. 165.

Examples of Vertical Milling. (Reproduced from a previous description of work done on the Becker Milling Machine.)

of the worm wheel is to be right-handed, the table is swiveled to the right, and to the left, if left-handed. For the hobbing, the bed is set back to zero.

Bevel and miter gears may be cut in either the plain or universal milling machines when equipped with an elevating index head. The teeth so cut are of approximate outline, but sufficiently exact for all ordinary uses. As shown in Fig. 160, the gear blank is mounted on a suitable mandrel held in the chuck or, as shown, fitted to the spindle bearing of the elevating head. The head is then elevated until the root line of the tooth is parallel with the work table. The proper cutter for the particular pitch and number of teeth is placed on the cutter arbor and brought central with the work. For any pitch the depth and width at the outer end of the tooth is the same as for spur gears. As the inner end of the space is narrower, the cutters for bevel gears must be thinner than for spur gears. The index having been set for the proper number of teeth a few center cuts are taken. The index pin is then advanced a few holes and the work moved out a few thousandths from the central position and the cutter again passed through the spaces already cut. This should remove some of the stock from the side of the teeth, taking more at the outer end than at the inner end. The index pin is next carried back double the number of holes it was advanced and the work moved in double the amount it had been moved out for the previous cut. This throws the cut on the opposite side of the tooth. As there is no fixed rule for the amount of these settings, the tooth must be measured and if not of proper thickness another trial setting must be taken. When

the proper settings are found for any particular gear, they should be noted for future reference. The center cut is then not necessary as the tooth is finished by the two side cuts.

For the cutting of spiral grooves as in the teeth of spiral milling cutters and spiral gears, a universal milling machine or the spiral cutting attachment, Fig. 149, February issue, in connection with the plain machine is required. In the cutting of any spiral the pitch of the spiral, the spiral angle, the number of teeth and the form of the cutter must be known Having this data, the work is placed between centers and the cutter brought over its center. The proper change gears for giving the required pitch are adjusted and the table swung toward the column the amount of the spiral angle. The rotation of the spindle must be left-handed for left-hand spirals, and right-handed for right-handed spirals, this change in direction of rotating being obtained by putting in or taking out an idle gear in the change gear mechanism.

The method of cutting a twist drill in the universal milling machine is illustrated in Fig. 161. The settings are as for cutting a spiral gear, with this difference, that the depth of the flute in a twist drill should be less at the shank end than at the point. It is therefore necessary to elevate the point somewhat. When the flute is to be cut from the very end of the blank, the shank must be held in a chuck on the spindle of the universal head, and for the outer end, supported on a suitable steady rest. If, however, the work can be carried on centers and the cutter dropped into its cut as close to the point as possible, better results can usually be obtained with less liability to accident. In this case, the head spindle can be dropped a few degrees below the horizontal position, or the tail center raised to give the proper taper to the web of the drill The backing off of the lands of the drill, as shown in Fig. 162, is a somewhat difficult operation, requiring good judgment on the part of the operator. The work table is swung through a small angle indicated by the line *r. a.*, which causes the end mill to cut deeper at *c* than at *e*, thus clearing the lip, as shown in the end view.

Figs. 163, 164 and 165 show examples of vertical milling machine work. In 163 the end mill in the vertical spindle is machining spots on the inside surface of a feed bracket casting. While this work, if clamped against a knee plate, could be done in a horizontal spindle machine with the same cutter, it would be much harder to hold and more difficult to get at for settings, measurements, etc. In Fig. 164, an angular cutter is shown, finishing the bevel face of a round casting, secured to a circular milling attachment. This work is done very rapidly and the same cutter is used to mill the internal face of the corresponding ring shown on the work table.

Frequently where duplicate work is held in the vise and its nature will permit, two vises placed side by side will greatly increase the output of the milling machine, as the work can be set up in one, while being machined in the other. In the milling of steel and wrought iron, oil should be freely used on the cutter as a lubricant and for conveying away the heat of friction. Cast iron and brass are milled dry.

The proper rotative speeds and feeds are very important as they are the principal factors upon which the output of the machine depends. As the toughness and hardness of the different grades of the several metals varies so much, it is impossible to lay down any fixed rules to be followed. With cutters other than the most delicate the very fine feeds are to be avoided, as the cutting edges stand up better under a moderately heavy cut than when scraping the metal away. The general practice now puts the speed of the cutting edges at about 40 feet per minute for cast iron and about 20 feet per minute for steel of ordinary hardness.

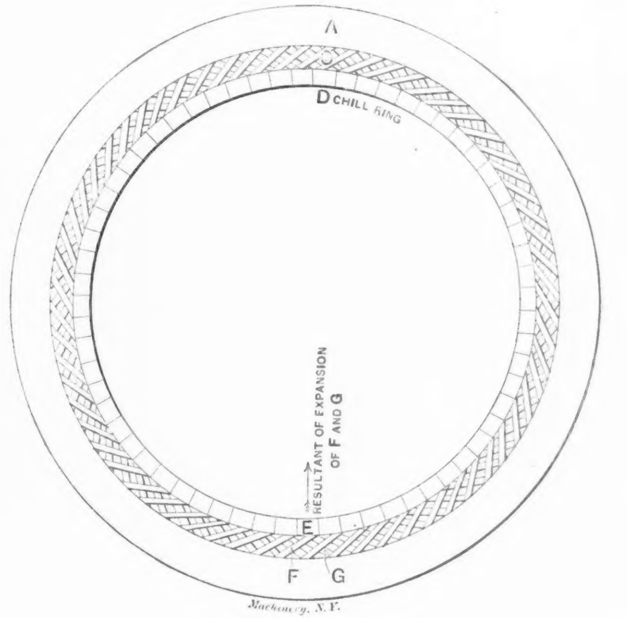
Milling cutters must be kept sharp. As soon as a cutter loses its keen cutting edges it dulls very quickly and does not produce smooth or accurate surfaces as it springs away from its work. A cutter must not be run backward when against its cut as the teeth are not strong against a backing pressure and are apt to be broken off.

Castings that are to be milled should be free from sand and hard, flinty spots. It is desirable to pickle them and in the case of small castings, which are very apt to be hard, to anneal them. These operations are inexpensive and rapid and will save many cutters and much grinding.

MAKING CONTRACTING CAR WHEEL CHILLS.

At the works of the Lobdell Car Wheel Company, Wilmington, Del., very effective use is made of the ubiquitous power hack saw in the manufacture of contracting car wheel "chills."

One form of contracting chill used is the Ford, which is outlined in the accompanying cut. The purpose of a contracting chill is to keep a ring of chilling metal in close contact with the cooling wheel and thus secure a maximum chilling effect. It is evident that where a solid ring chill is used, as the metal is poured, the wheel at once begins to shrink in size while the chill at once commences to grow larger in diameter on account of the expansion caused by the heat absorbed from the molten metal. The result is that the tread of the wheel is not chilled to the maximum depth, and the wheel is likely to be not perfectly round. In the Ford chill the chill ring *D* is separated from the outer ring *A* by a space of about two inches and is tied to it by the diagonal braces shown, the whole being one piece of cast iron. The chill ring being divided into the short segments indicated and each segment attached to a pair of the diagonal braces standing in opposite inclination as at *F* and *G*, the effect of the hot metal composing the wheel is to cause the chill ring, as a whole, to contract. The reason for this is that when the metal is poured the chill segments



The Ford Contracting Chill.

heat up quickly and transmit a considerable degree to the diagonal braces supporting each segment. The outer ring *A* being separated by the air space, heats slowly from the heat transmitted through the diagonal braces, and as a result of the expansion of these braces, each segment is forced radially inward and thus approximately follows up the cooling wheel.

In making these chills the chill ring is cast solid, and after being bored for the wheel tread, is sawed apart at the proper points to secure the attachment of one segment to a pair of diagonal braces, as already explained. The number of segments on a wheel chill ranging from, say, sixty to one hundred, made it desirable to devise some method of cheaply cutting them apart. For this purpose eight Miller's Falls power hack saws were arranged in two rows of four each, back to back, and by each machine was planted a stout post running from the floor to the ceiling. On each post was secured a roller at the proper height, to carry the weight of a chill, and at one side a smaller one was stationed to prevent side movement. A simple indexing device for each chill completed the arrangement, which is tended by one man, his duties being to properly index the chills as the cuts are finished and to maintain the supply.

* * *

It is claimed that Edward Weston discovered that power could be transmitted by electricity, using a dynamo and a motor for the purpose, and that he demonstrated it before a number of witnesses in 1876 at Newark, N. J.

LETTERS UPON PRACTICAL SUBJECTS.

RIG FOR HOBBING WORMWHEELS.

Editor MACHINERY:

Having a wormwheel to hob like that shown in the half-tone, Fig. 1, and having no special hobbing machine for the purpose, we rigged up a Brainard milling machine for doing the job as shown in Fig. 2.

At the base of the machine are shown the parts that were necessarily removed. A new shaft, *A*, was put in, with the gear, *B*, fitted so as to be free to slide longitudinally on a

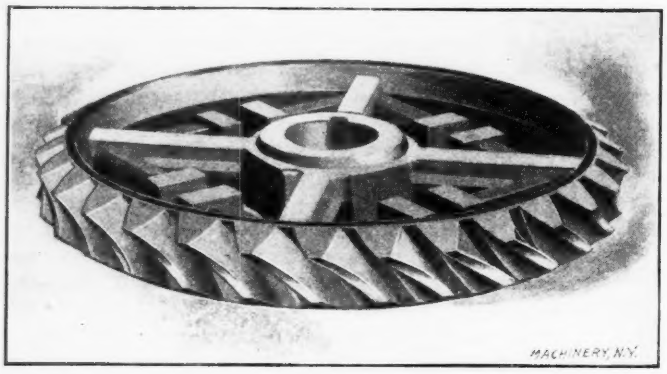


Fig. 1. Completed Wormwheel.

feather. The back end of the shaft was fitted at *C* and *D*. The casting, *E*, was fitted to a new shaft in place of the feed belt cone and was made with a slot to accommodate the change gears. It replaced the part at the base of the machine marked *L*. On the milling machine platen is the fixture for holding the wheel to be hobbed and for turning it as the hobbing proceeds. The wormwheel *H*, is engaged with the worm *I*, which is mounted on the same shaft as *J*. Gear wheel *J* meshes with gear *B*, which is driven through the change gears by the main spindle on which is mounted the hob *K*. The ratio of the

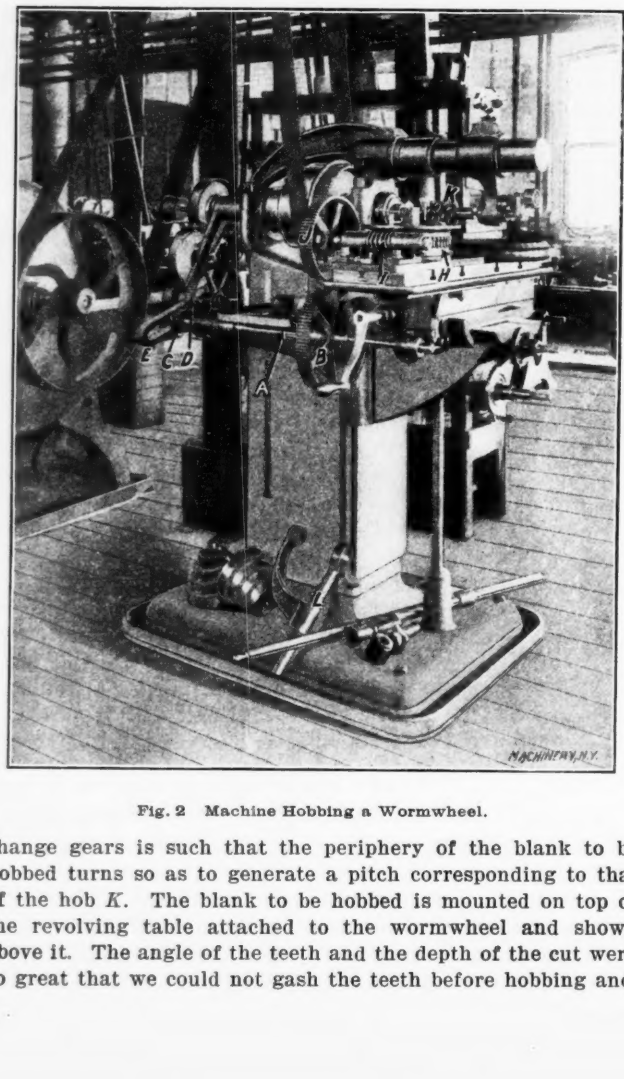


Fig. 2 Machine Hobbing a Wormwheel.

change gears is such that the periphery of the blank to be hobbed turns so as to generate a pitch corresponding to that of the hob *K*. The blank to be hobbed is mounted on top of the revolving table attached to the wormwheel and shown above it. The angle of the teeth and the depth of the cut were so great that we could not gash the teeth before hobbing and, consequently, had to do it all with the hob, which necessitated the driving mechanism for the blank.

The pitch diameter of the wormwheel is 10 5-16"; the number of teeth is 30; the worm has 6 threads, with a pitch of 6.48"; pitch diameter of worm 2", and outside diameter 2⅝".

While the rig is something of a novelty in milling machine practice, it did a very good job.

Lawrence, Mass. FRED J. PERRY.

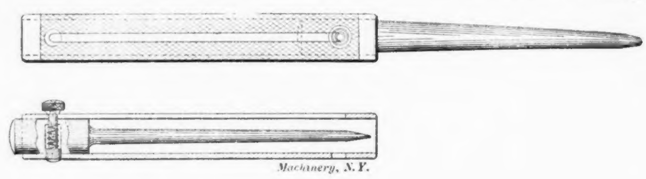
[It will be observed that the circumference of the worm at its pitch diameter, 6.28", is nearly the same as the pitch of the sextuple threads, so that the pitch angle is practically 45°, or that of the greater efficiency.—EDITOR.

* * *

ANOTHER BELT AWL.

Editor MACHINERY:

I notice on page 158, Vol. 7, January, 1901, issue of MACHINERY a description of an improved belt awl. I send you herewith photograph of another belt awl which I have



Belt Awl.

made. The awl slides within the hollow handle, the handle being knurled on the outside, and the blade is attached to the handle by the locking bolt. You will notice that this awl cannot be lost without losing the whole tool.

Hartford, Conn. C. E. BILLINGS.

* * *

SOME FUTURE POSSIBILITIES OF ALUMINUM.

Editor MACHINERY:

Most people can remember when aluminum was a curiosity. It is only a few years ago since tokens bearing the legend "good for 5 cents over the bar," issued by some enterprising saloon-keeper, were considered of sufficient interest to warrant their being kept as pocket pieces. To-day, however, the enterprise of such firms as the Cowles Electric and the Pittsburg Reduction Co. and others, has reduced the price of the metal to such an extent that, weight for weight, it is as cheap as brass. When the white metal first became a commercial possibility, enthusiastic predictions were made as to its future. We were told that in strength and tenacity it was equal to steel, which metal, and also iron, it was going to supplant to such an extent that instead of this being an age of steel, the twentieth century would usher in the age of aluminum.

Time, however, has modified these views. Steel still holds its own in its especial province, and aluminum has reached its level as all things must, although it is now no longer used in place of the wonderful alloy of iron and carbon where the strength, tenacity and rigidity of steel are required. The new metal has a field of its own, and has become a familiar object to every schoolboy in the land. It is cast and stamped and spun into a thousand articles of art and utility. It is made into pots and kettles, sugar bowls and spoons, combs, cigar cases and thimbles. It has been built into boats, and cast into wheels for automobiles, and drawn into wire for telephone and other electrical purposes; while its lightness has disposed of one of the many problems that confronts the inventor who is working to construct a machine that will fly.

As the strength of cast aluminum is about equal to that of cast iron, it will undoubtedly displace this metal in the aerial machine of the future. But aluminum possesses properties which open up possibilities that its most enthusiastic exponents never dreamed of in the early days. Then, it was regarded solely as a metal that would take the place of, or be alloyed with, other metals, producing results superior to what was possible before it was known. At the present time the future of aluminum seems to be more in the line of storing energy than as a mere metal.

As is well known, it is not a scarcity of the metal, but the

difficulty of reducing it from its ores, that has made aluminum a commercial possibility only in the latter part of the nineteenth century. Although it is one of the most widely diffused metals known, existing everywhere, in the earth, rocks and clays which constitute this globe, it is never found in the metallic state, like gold, silver and copper, but is only reduced from its richer ores by the expenditure of enormous mechanical energy, and this was not possible, on an extensive scale, before the knowledge of electricity had reached the point of application in the electric furnace.

Quite recently it has been discovered that aluminum, under certain conditions, can be made to give up the greater portion of the energy that was necessary to produce it; returning in so doing, to its native state, from which it can be again reduced, and so on. So it is no wild dream to imagine that the future may witness the power of Niagara, stored up in the compact form of a metal, which may be carried into our homes and workshops, or to any portion of the earth's surface, and there liberated in the form of mechanical or electrical energy.

It has been long known that aluminum when heated with certain metallic oxides and salts would combine with dangerous avidity. A small portion introduced into melted red hot sulphate of soda will decompose that salt with such intensity that the crucible will be shattered into a thousand pieces and the furnace probably partially destroyed. Sometimes accidents occur in foundries from this cause, and men get burned when alloying aluminum, as a piece of cadmium the size of a pea, introduced into a crucible of molten aluminum will cause an explosion that will throw the metal in all directions. But it is the property which aluminum possesses of decomposing the oxides of other metals that has recently been put to industrial uses, as described in the last number of MACHINERY. A German chemist has discovered that when powdered aluminum is mixed with iron oxide or rust, in the proportion of its chemical equivalents and gradually ignited, the iron is reduced and the aluminum combines with the oxygen, liberating an intense heat which can be utilized in welding iron and steel and reducing refractory metals.

This mixture of iron and aluminum is being manufactured on a commercial scale and is called thermit. When it is desired to use this substance in welding, rails, for instance, a small quantity is placed in the bottom of a crucible and ignited. As thermit requires considerable heat before it will take fire, a pinch of some other chemical that will take fire easily is placed on top and lighted with a match, and sufficient heat is thus generated to ignite the thermit, when more thermit is added, gradually, until the crucible is filled with the mixture. About 3000 degrees centigrade of heat are liberated; the aluminum takes the oxide from the iron and floats on the top as a slag, while the pure molten iron at a dazzling white heat occupies the lower part of the crucible. If this mixture is now poured over and around the joints of rails, the latter become so heated that they immediately weld when squeezed together.

Any other oxide than iron can also be used, but iron is cheapest and is, consequently, the only thing used when heat only is desired. But when other refractory metals are desired in a state of purity, aluminum affords an easy method of reducing them. The oxide of the metal desired is mixed with aluminum and ignited in a vessel of refractory material in the same manner as thermit. If the production of the metal is to be continuous, it is constantly tapped from the bottom of the vessel, while the slag is run out at the top, new material being constantly added. Thus a very small furnace will produce a large quantity of metal.

Probably like most other inventions of the age, thermit may find a use in warfare. One would imagine it would be more to be dreaded than the dum-dum bullet. Consider the effect of a shell filled with liquid fire, exploding in the midst of a body of men or among the houses of a besieged city. Had the Boers thrown a thing like this into Kimberley or Ladysmith, there would have been trouble. Or if the English were a second time besieged in Gibraltar, they would not need to make bonfires to heat their shot as in the last historic siege. They could fill the hollow portion of an armor-piercing projectile with the liquid metal, which, being wrought iron, would solidify almost immediately into a white hot mass of metal; and might then be thrown from a twelve-inch gun among the enemy's battleships.

C. VICKERS.

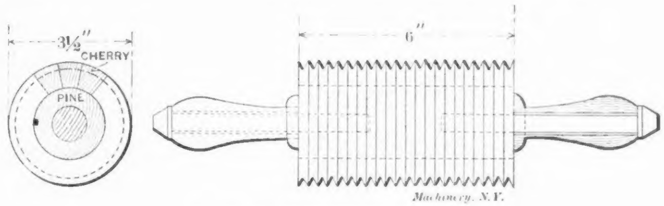
Chicago, Ill.

* * *

RULING ROLLER.

Editor MACHINERY:

In the office of the company by which I am employed the clerks often require their books ruled with about 20 lines to a page vertically, which used to be done with the common pen, one line at a time. The writer was asked if he could not make a roller that could be inked from a pad similar to those in use for rubber stamps. My first attempt was a failure, on account of the edges of the roller breaking away, it being turned from a piece of cherry with the grain running lengthways. I then made one as per sketch shown herewith.



Roller for Ruling Parallel Lines.

A core of pine 2" diameter was first turned and then staves of cherry cut from a board ¾" thick, wide enough to equal the length of core, and after fitting each one and soaking in good hot glue for a few minutes were severally attached to the central piece. The outside diameter of roller was 3½ inches which was large enough to travel the length of the page with one revolution. The handles ran loose on a central pin, glued in the core piece. Owing to the end grain of staves standing radially I was able to make and retain nice sharp ruling edges which made neat lines. The pad, which was ordered especially for the purpose, cost a dollar.

Oneonta, N. Y. WM. NEWTON.

* * *

INSERTED FORMING TOOL FOR LATHE OR PLANER USE.

Editor MACHINERY:

In a great many shops I have found an unnecessary waste of steel and time in forging lathe or planer tools for forming work. In many instances after a tool has been made and once used, it is carelessly laid aside until the next time when it is wanted it cannot be found and the chances are that when it is found it will more resemble a chisel than a forming tool.

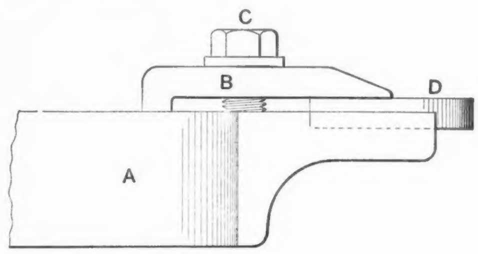


Fig. 1

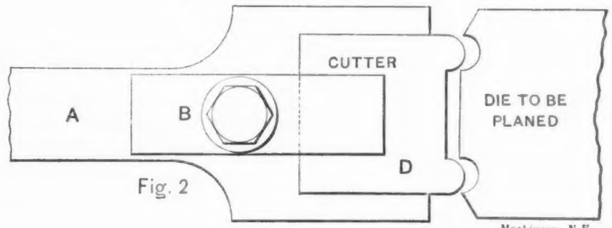


Fig. 2

In the accompanying cuts, Figs. 1 and 2, machinists and tool-makers will find the design of a handy forming tool for turning or planing all kinds of various outlines. The holder *A*, used by myself, is forged from regular lathe tool stock and planed out at the end for the slot which is 1" wide and ⅛" deep, to receive the cutter *D*. To make the cutters, plane a piece of steel, say 14" long, to a width of 1" and a thickness of 3-16" and cut off into sections of 1" long. These dimensions are only comparative and are suggested by the tool made.

The cutters, when not in use, can be kept safely in the toolbox where they will be available when again wanted.

New Haven, Conn. W. L. HENSLEY.

* * *

TO FIND THE STEP DIAMETERS OF CONE PULLEYS.

Editor MACHINERY:

The calculation of the step diameters for cone pulleys is a subject that has been pretty well threshed over in the effort to obtain an accurate and simple formula which will give the diameters correctly with both long and short center distances. There is, I believe, no simple formula known that gives exact results; nevertheless, I was surprised to note the answer given to an inquirer on the subject in a recent number of a technical magazine, the assumption apparently being that so long as there was no exact simple method known it was useless to give the correspondent any approximate method.

The inquiry was to the effect that two cone pulleys were to be set 24" apart, center to center, and that one pulley was to have three steps 7½", 5" and 3½" in diameter, while the middle step on the other pulley was to be 10" in diameter, the information required being, of course, how to obtain the diameters of the other two steps. The answer was that no simple and reasonably accurate formula for calculating the dimensions of the required steps was known, but that a number of graphical methods for solving such problems were extant. The subject was dismissed by referring the writer to an elaborate work on design. The answer may have been eminently satisfactory to the editor, but scarcely so to the correspondent. It is, at any rate, misleading.

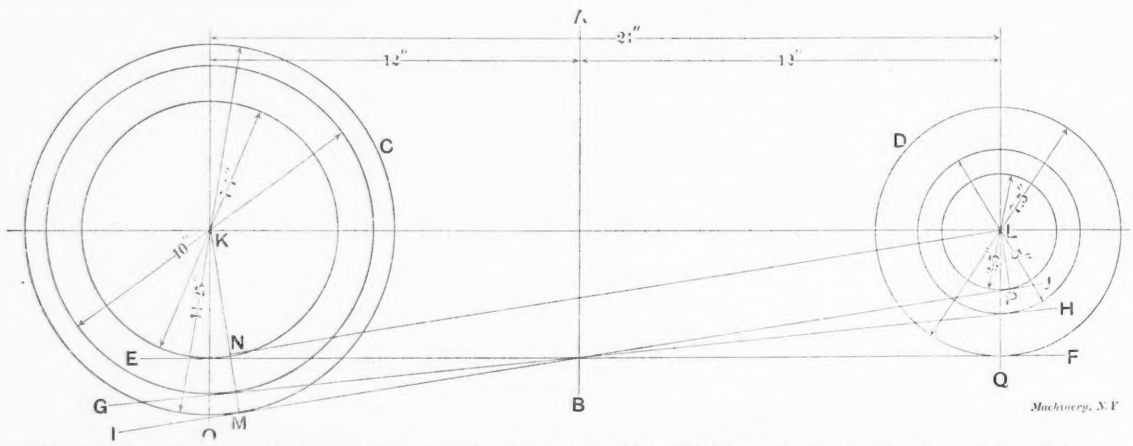


Diagram illustrating proof of approximate method and also a graphic method for proportioning the steps of Cone Pulleys.

The question is: What is reasonably accurate, and how accurate must the various dimensions of stepped pulleys be to run satisfactorily? Would the mathematical expert who had calculated the different diameters by trigonometry to four significant figures be satisfied that the result was reasonably accurate? If so, it might be a shock to him to know that when exact results are wanted one-half the belt thickness must be taken into consideration, both in the resultant ratios and the tension of the belt on the various steps. This desire for mathematical accuracy in the calculation of the steps of cone pulleys might be proper if the belt was made of some practically inelastic or non-stretching substance like steel, but the man who knows he is to use good everyday leather belting does not care whether the steps are exact to a few thousandths of an inch or not because he knows that the elasticity of the belt will safely take care of slight differences.

The aim in designing a cone pulley is to so proportion the various steps as to obtain certain ratios, and at the same time have them of such sizes that the belt will run on any pair of steps, the belt length thus becoming the limiting condition after the ratios have been determined. The following formula for the length of an open belt is derived from the well-known Rankine formula for finding the step diameters:

$$\text{Length of belt} = 2C + \frac{11D_1 + 11d_1}{7} + \frac{(D_1 - d_1)^2}{4C} \text{ in which}$$

C = center distance between the pulleys.

D_1 = diameter of first step on cone No. 1, the other steps being characterized as D_2, D_3, etc.

d_1 = diameter of first step on cone No. 2 followed by d_2, d_3, etc

By this formula the belt length can be found for the pair of steps given and then by using the belt length the diameters of the other steps can be readily found in terms accurate enough for almost any requirements, but to use it, it is necessary to keep the unknown diameter on the right hand of the equation in the relation as expressed above until the known members have been substituted, after which the unknown quantities may be transposed to the left.

Taking for an illustrative example the problem referred to, we have

$$\text{Length of belt} = 48 + \frac{110 + 55}{7} + \frac{(10-5)^2}{96}\ 71\tfrac{559}{672} \text{ inches}$$

necessary for the middle steps. To obtain another step, say D_1, the formula leaving out the sub-figure for clearness, will read:

$$71\tfrac{559}{672} = 48 + \frac{11D + 82\frac{1}{2}}{7} + \frac{(D - 7\frac{1}{2})}{96} \text{ from which}$$

$$7D^2 + 951D = 7701.25$$

$$D^2 + \frac{951D}{7} = 1100.18$$

Completing the square gives

$$D^2 + \frac{951D}{7} + \frac{904405}{196} = 1100.18 + 4619.4$$

$$D + \frac{951}{14} = 75.63 = 7.7 \text{ inches diameter of } D_1$$

In the same manner the diameter of D_3 is found to be 11.25 inches. The actual belt length for two steps D_3 and d_3 with a center distance of 24" is 71.798" or .034" less than that required for the middle step. This difference of slightly more than 1-32" would not have a serious effect under practical conditions.

To prove the result the actual belt length for these two steps may be found as illustrated in the accompanying diagram. The line IJ is drawn tangent to the 11.25" and 3.5" circles at the point M and F. The distance MN is set off on the radius MK equal to one-half the diameter of the 3½" step and the line NL drawn parallel to IJ. The triangle KNL is therefore a right angled triangle with the right angle at N.

$\overline{LN}^2 = \overline{LK}^2 - \overline{KN}^2$ or LN = 23,685", the length of straight belt on one side. Two times 23.685 = 47.37" the total length of straight belt. The quotient of 23.685 ÷ 24 = .98687, the sine of angle NKL, which equals 80° 42′. Angle OKM equals 90° — 80° 42′ or 9° 18′. The circumference of the 11.25 step embraced by the belt is, therefore,

$$\frac{180^\circ + 2\,(9^\circ\,18')}{360^\circ} \times 11.25 \times 3.1416 = 19.498''.$$ The circumference of the 3½" step embraced by the belt is $\frac{180^\circ - 2\,(9^\circ\,18')}{360^\circ} \times 3.5 \times 3.1416 = 4.93''$. The sum of 47.37 + 4.93 + 19.498 = 71.798"; the length as calculated is 71.832".

The graphical method for proportioning cone pulleys also illustrated by the diagram is a quite accurate means for obtaining the different steps when carefully laid out to one

half, or full scale when the center distances are short. It is so well known that there is no need for me to more than mention it here. A further elaboration of this method which makes it slightly more accurate will be found in the transactions A. S. M. E., vol 10, and in Kent's pocketbook.

Newark, N. J. F. EMERSON.

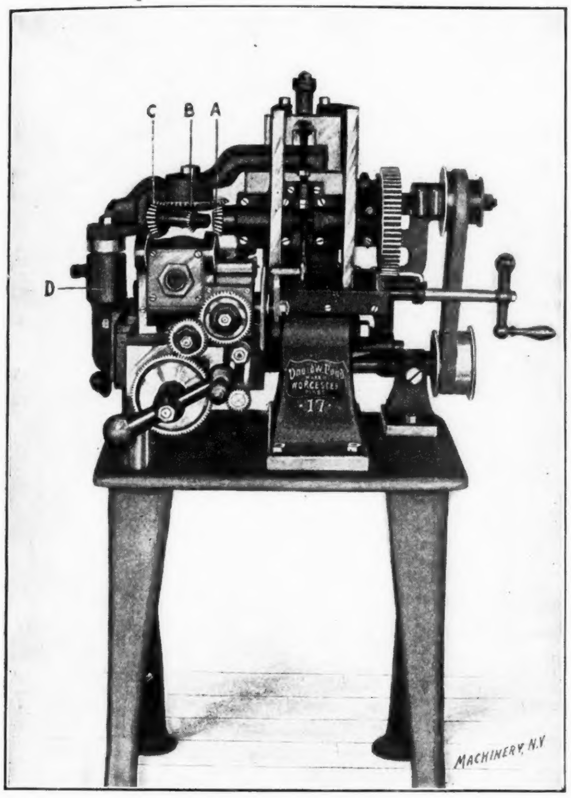
* * *

RIG FOR CUTTING SPIRAL TEETH.

Editor MACHINERY:

I enclose a photograph of a milling machine which has been rebuilt and supplied with additions from time to time to suit new jobs as they came along.

The machine is shown set up for milling spiral-tooth cutters about 1″ in diameter, ¼″ thick, with a ⅜″ hole and something like 40 or 50 teeth as I remember them. The blanks were made in the screw machine by two operations upon a solid rod. When ready to be milled the blanks were put on a collar arbor on the dividing head, 12 at a time.



Milling Machine and Attachment.

The interesting feature of this rig is the novel way of obtaining the angle of the spiral, and there is no reason why the same principle could not be applied to other special machines, where it is desired to set the cutter at an angle with the table. The cutter is driven by the main spindle through the bevel pinions A and C and the intermediate gear B. The arm carrying the intermediate gear B is supported from the sliding head of the machine and is raised and lowered with this head. The cutter spindle is supported by a swinging frame pivoted at the axis of the intermediate bevel gear. The left or outer end of the swinging frame is supported by the casting D bolted to the frame of the machine. When the cutter is raised or lowered the setscrew in piece D is loosened so that the outer end of the swinging arm will be free to slide in D. After the cutter is adjusted to position the swinging frame can again be clamped. The cutter is brought central with the work by making collars on the cutter arbor of a length to suit the conditions.

S. J. P.

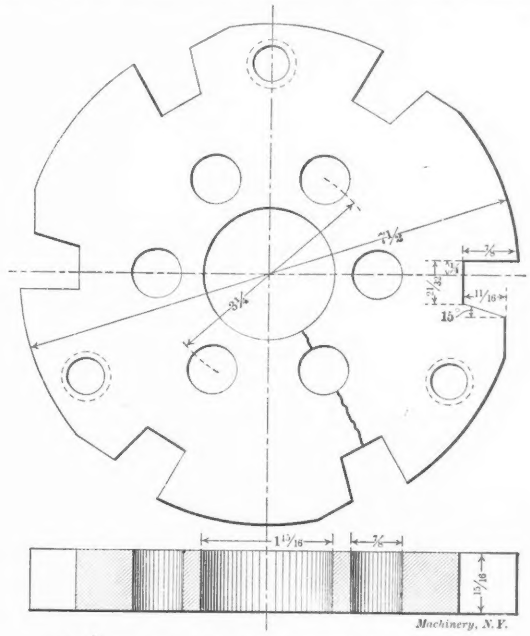
* * *

CRACKED IN HARDENING.

Editor MACHINERY:

The illustration herewith shown has been the cause recently of several lengthy and animated conversations between "the-great-I-am" and the foreman of a down east shop, suggestive of better material in the form of a foreman.

This sketch illustrates the index ring of a hexagon turret head, which was to be hardened, and which persistently cracked in so doing. The rings were made from punched blanks, bought for the purpose, and were supposed to be Norway iron, but presumably were only soft steel. They were heated in a small case-hardening furnace run with hard coal, and forced draft from an ordinary blacksmith's forge blower. They were heated in granulated bone for six or eight hours, then plunged into cold water. The results were fast shattering all hopes of summer vacations, 10 per cent. profits, etc.,



Index Ring for Turret Lathe cracked in Hardening.

as well as the rings themselves, and something had to be done.

The foreman reasoned that there being so many holes in the center of the piece, allowed this part to cool more quickly than the outside. Then, as the outside cooled, the effect was the same as a band being shrunk around the center piece, which caused an undue strain, and caused the crack. The idea was then conceived of filling up all the holes with clay to retard the cooling at the center, with the result that the pieces are now hardened with very seldom a cracked one.

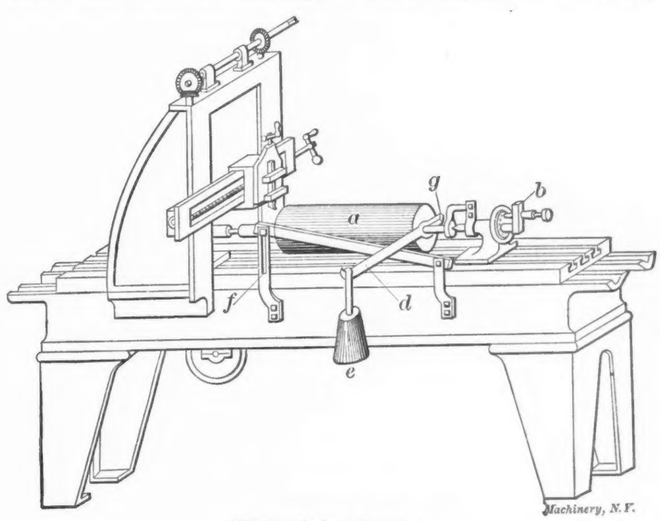
Dexter, Me. W. L. FAY.

* * *

A SIMPLE METHOD OF FLUTING A SPIRAL ROLL.

Editor MACHINERY:

While employed in a jobbing shop some time ago, I was called upon to make a roll with spiral flutes. This roll was for use in a paper mill, was made of cast iron and had wrought-iron pieces cast in for the bearings. First of all, cutters or blades



Rig applied to Planer.

were dovetailed in it and ground to an edge. This completed the roll which was now centered, turned to size and made ready for the planer—the only available tool in the shop with which to do the fluting. The braces were now forged to

the proper shape, one of them being slotted at *f*, as in the figure, for adjustment to the spiral. A straight bar or former was then connected to these braces as indicated, the planer centers were put in position and the lever *d* was clamped on the roll shank with a common lathe dog engaging the carrier on the index head. This lever was split at *g*, which enabled it to be loosened when a division of the roll was required. The weight *e* was used to keep the lever down on the former while the planer was cutting. The index pin *b* should be disengaged when cutting the spiral and lever *d* loosened when getting other divisions.

This is the simplest and cheapest method I have yet seen for fluting rolls with the use of a planer or shaper.

Lynn, Mass. GEORGE W. FREEMAN.

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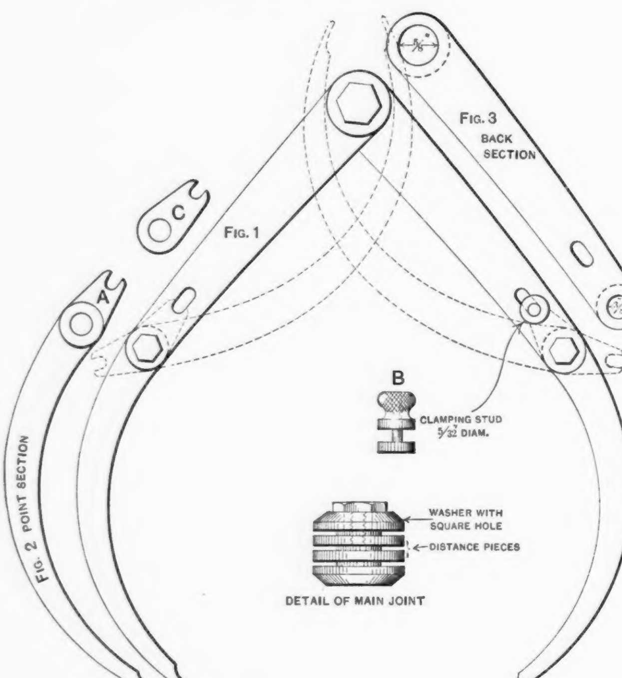
DOUBLE-JOINTED CALIPERS TO FOLD IN TOOL BOX.

Editor MACHINERY:

The following is a description, with sketch, of large calipers that can be folded up and put in a machinist's ordinary size tool chest. The usual large caliper supplied by the average machine shop is so cumbersome and heavy that this one was designed to fill its place. It can be carried in the chest when the usual style large caliper cannot. It is a very light and compact tool, and not at all springy. It is a 26" caliper, and will caliper up to 34" diameter. The back sections are made in four pieces, and the point ends fit between the back half like the blade of a knife. (See sketch.) Each side of the back or front section is made of saw steel 1-16" thick, and the front part or point of steel is ⅛" thick. The double section makes the tool very stiff and light.



Folding Calipers.

The point section has a tongue, *A*, extending between the double section which is engaged by the sliding stud and thumb nut. The stud is a nice sliding fit in the slot, and the thumb nut clamps it firmly in place when in use. *B*, in the figure, shows the position of the thumb nut. *C*, is a sheet copper liner put between the washers at *A*. The dotted lines show the points folded back to close up. The large joint washers are 1¾" diameter, and a ⅝" pin with a ⅜" octagon screw tightens it up. The forward joints are the same style but smaller. The main joint has two 1¾" brass distance pieces or washers between the two washers. The back section is 12½" between centers, and the front 15" from center to point. Closed up they measure 16" over all.

Dubuque, Ia. E. J. B.

METHOD OF TURNING BALLS.

Editor MACHINERY:

The following is a description of a method that I have used for turning brass balls. They were turned from a brass rod 1 1-16" in diameter which was held in the chuck of a lathe. The chuck was a three-jaw universal chuck. Fig. 1 illustrates the manner of roughing out the ball. A special rest, *A*, was used pivoted exactly below the center of the ball being turned. The tool was set so that very little stock had to be removed in the finishing process. The stop pin shown at the back

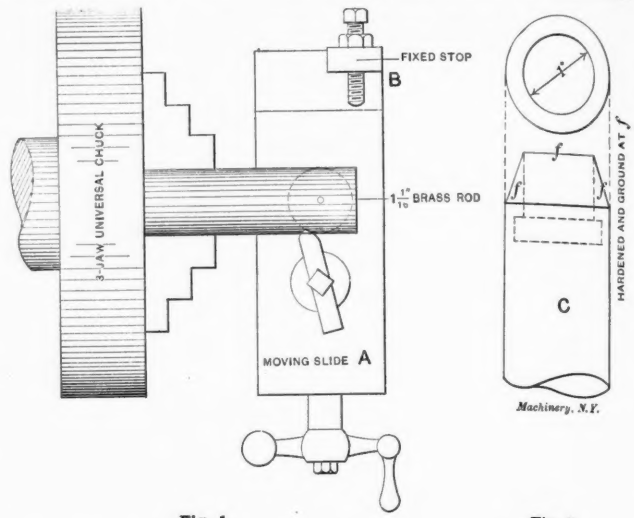


Fig 1. Fig. 3.

of the slide served to gage the depth of the cut made by the roughing tool, and determined the size of the ball. The tool and stop pin were adjusted so that after roughing, the ball would be attached to the brass rod by a neck about ⅛" in diameter, as shown in Fig. 2. After applying the finishing tool the ball was sawn off. Before completely severing the ball, the point where it was attached was finished as far as possible with a file and finally finished completely by running over this spot with the finishing tool, which was very easily and quickly done by holding the ball in the hand during the operation. Practically perfect spheres were made by this process at the rate of about 20 per hour.

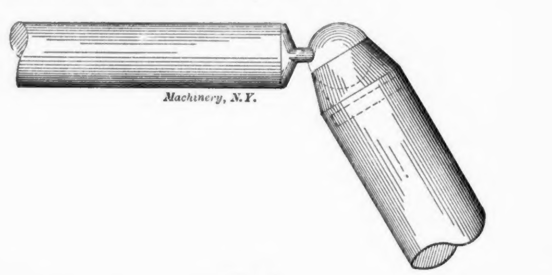


Fig. 2.

The finishing tool is shown in Fig. 3. It was made of a piece of 1¼" round tool steel, hardened and ground, being finished only at the surfaces marked *f* in sketch. The hole drilled in the end of this tool was recessed as indicated, to enable the emery wheel used in grinding the interior to clear. Fig. 2 shows the method of finishing the balls with this tool. The tool was held in the right hand and was moved to the right until it stood in line with the lathe centers and to the left as far as possible. It is obvious that after the ball is turned to such a size that it will just enter the finishing tool, it is completed, and it is also obvious that it is impossible to get the ball under size.

Chicago, Ill. BERT LACHMAN.

* * *

THE TEMPER OF STEEL.

Editor MACHINERY:

That temper has always been considered an essential attribute, is evinced by the fact that, in the long use of the word, several diverse meanings have survived. When man considered himself justified in ascribing to the deity anthropomorphic conceptions, temper was always one of these attributes. This concerns us but indirectly, and of the various uses of the word, the one of most importance to the engineer

and machinist—its meaning when used in reference to steel—is the one selected for use in this article.

To obtain an adequate understanding of this use of the word, it is necessary to know something of the structure and properties of steel. In structure, steel is a chemical compound of iron and carbon generally containing some other element as silicon, sulphur, phosphorus, etc. It contains no free, or graphitic, carbon as does cast iron; its tensile strength is greater than wrought iron, and its compressive strength greater than cast iron. The strength of steel varies greatly with its purity and the amount of carbon which it contains. Unlike wrought iron, it is fusible; unlike cast iron, it can be forged; and, with the exception of very low grades, possesses the valuable quality of hardening when suddenly cooled. Steel is made in one of the following ways: 1. By adding carbon to wrought iron; 2. By removing carbon from cast iron; 3. By melting together cast and wrought iron in suitable proportions. When a clean piece of steel, hardened or unhardened, is exposed to heat in air it will assume different colors as the heat increases. It is a well established fact that these colors are due to thin films of oxide that are formed as the heat progresses. These colors are as useful as beautiful and furnish an unvarying guide, with a given grade of steel, as to the condition of the hardened tool. Tempering steel is the act of giving it, after it has been shaped, the hardness necessary for the work it has to do. In most cases this is done by first hardening the piece generally a good deal harder than is necessary by suddenly cooling from a low cherry heat, and then toughening it by slow heating and gradual softening until it is just right for the work it has to perform. A modification of this latter process consists in hardening the outer surface by a momentary chilling, and then allowing the still heated portion of the tool to raise the temperature of the chilled and hardened portion to the desired point, when further rise is prevented by a sudden quenching.

The word temper, when applied to steel, has, unfortunately, two diverse meanings. The steel manufacturer uses the word to designate the amount of carbon which steel contains; and the worker, the color of the oxide at a given temperature.

The table given above is arranged with a view to place manufacturers' and workers' meaning of the word temper in immediate contrast, so that a better understanding may be had by those unfamiliar with the "other side." As a rule the quantity of carbon, or other ingredients, in steel is usually designated in one hundredths of one per cent.; thus ten carbon means ten one-hundredths of one per cent. 100 carbon steel, i. e., steel containing one per cent. of carbon, is the strongest in every way, as this percentage is about the saturation limit.

The uses given for temper colors and the other data in the table herewith are to be taken as merely giving a good general idea; experienced men are guided by results, and select and temper in the way that gives these results. Data arranged from Metcalf, Thurston, and Rose. Color scale as observed.

STANLEY H. MOORE.

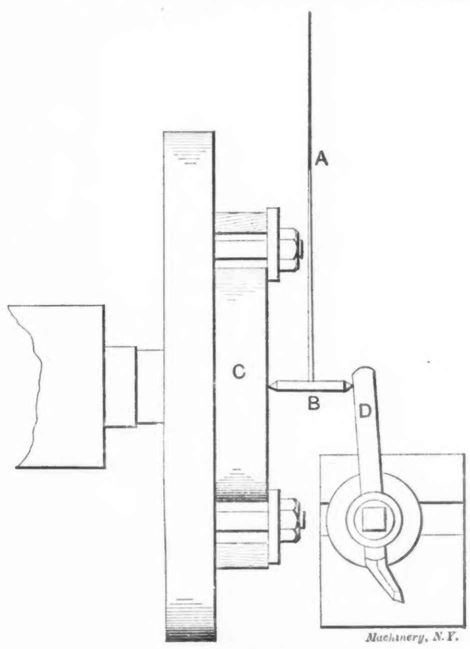
Manufacturers' and Purchasers' Data.			TEMPER.	Workers' Data.		
Suitable for	Characteristics.	Manufacturers meaning for temper.		Workers meaning for temper	Temperature of piece at this color Fahr.	Tools hardened at this color and temperature.
Razors, and extra fine tools.	Very difficult to forge and easily burned.	150 Carbon or more.	VERY HIGH.	Light straw.	430	Hammer faces, Tools for steel, Engraving tools, Files and Speed Lathe tools.
Saw files, and fine tools.	Bears heat not above cherry redness; requires great care in working.	100 to 120 Carbon.	HIGH.	Straw.	460	Lathe and Planer tools, Milling cutters, Screw cutting dies, Taps and Reamers.
Lathe and planer tools. Cold chisels.	Can be made to so called "weld".	85 to 95 Carbon.	HIGH MEDIUM.	Brown.	490	Twist drills, Plane irons, Chisels and bits.
Cutting tools.	A good all around steel.	70 to 80 Carbon.	MEDIUM.	Pigeon wing.	540	Hack saws, Wood chisels, Axes.
Tires.	Works somewhat like wrought iron.	40 to 60 Carbon.	MILD.	Dark blue.	570	Springs, Fine saws.
Boiler plates, Axles.	Tempers slightly.	20 to 30 Carbon.	LOW.	Pale blue.	610	Common saws, Some springs.
Pieces of machinery.	Does not temper.	Under 20 Carbon.	SOFT.	Greenish blue.	630	Too soft to be useful.

Table of Steel Tempers.

SIMPLE CENTER INDICATOR.

Editor MACHINERY:

In the January, 1901, issue of MACHINERY under the heading of "Shop Kinks" there are some center indicators shown. I also have a center indicator which has been used in the shop and which is very simple to make and to apply.



Center Indicator.

The piece B is made of steel 3-16" round by $1\frac{1}{2}$" long, and the points or ends are hardened. The part A consists of a piece of No. 42 drill rod of suitable length, with the end ground to a point. The application is as follows:

The work C being clamped to the face plate, the indicator is held between it and the tool D, or any suitable piece of iron, both having prick punch indentations in them. Any variation of the center of C is shown by a movement of the point A.

Detroit, Mich. WILLIAM E. DYER.

* * *

A second edition of the lecture by Walter B. Snow, on "Mechanical Ventilation and Heating by a Forced Circulation of Warm Air," has just been issued by the B. F. Sturtevant Co., Boston, Mass., by whom it will be mailed on application.

NEW TOOLS OF THE MONTH.

Under this heading are listed the new machine and small tools that have been brought out during the preceding month. Manufacturers are requested to send brief descriptions of their new tools as they appear, for use in this column.

The Geometric Drill Company, Westville, Conn., are now making their self-opening screw-cutting dies large enough to cut standard pitches up to 3½" in diameter, and are using them in connection with engine lathes to thread work of this size at two cuts instead of running it over perhaps a score of times or more with a single-point tool in the old way.

The Perkins Machine Company, South Boston, Mass., are building a "snagging" shaper designed exclusively for rough, heavy work, such as cutting off sprues and riser heads of steel castings and for any such work where a shaper must do heavy work of a rough character and is likely to receive rough usage. A large vise is provided, having jaws 24" long and which open to 20". The ram is long and of substantial design, and has a stroke of 18". The ram is driven by a Whitworth quick-return motion, giving it a speed of 3 to 1 on the return stroke.

The Chattanooga Machinery Company, Chattanooga, Tenn., have recently brought out a new keyseater made in four sizes. The smallest size cuts keyseats ⅛" to ¾" wide and 10" long, and the largest, ⅛" to 3" wide and 30" long. The machine works on the draw-cut principle and with the cutter bar in a vertical position. The cutter bar is operated through a pinion meshing into a rack attached to the lower end of the cutter bar. The reversal of stroke is effected by dogs attached to a slotted disc mounted on a horizontal rock shaft on one side of the base. The machine contains a number of interesting features which distinguish it from others of the same type.

SMALL PNEUMATIC MOTOR.

A pneumatic reversible motor is shown in Fig. 1, designed to rotate a spindle in which may be fitted different kinds of tools for use in the construction of metal work and machinery

The spindle is at the extreme end so that it can be operated at close quarters, as in drilling I-beams, where the point of the feed sleeve can be set against one flange and the point of the drill against the other. The motor has two oscillating cylinders of bronze brass, taking air at both ends, and the admission and exhaust are controlled by the oscillation. The trunnions have steel ferrules to protect them from wear. In the main frame there are two air chests (one on each side), one for live air, the other for exhaust, and by turning the

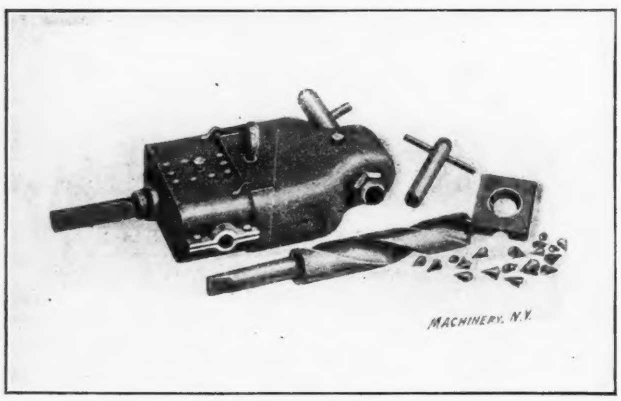


Fig. 1. Pneumatic Motor.

handle half-way around the functions of these chests become reversed, thereby reversing the motion. By a quarter-turn of the handle the motor stops. The air is admitted and exhausted through the handle, which also has an adjustable collar that can be set so that the motor will run but one way. It has a detachable handle which is used when the drill is suspended or when used for tapping and reaming. The motor is manufactured by the Helwig Manufacturing Co., St. Paul, Minn.

HEAVY DOUBLE-SPINDLE LATHE.

A new heavy pattern double spindle lathe has been brought out by J. J. McCabe, 14 Dey St., New York. The two spindles swing 26" and 48" respectively, and the gearing and general proportions of the lathe are such that the full capacity of the upper spindle can be used to advantage. The upper spindle is triple geared and an internally geared faceplate, ratio about 55 to 1, can be furnished for unusually heavy work. The lower spindle is back geared. Some of the essential features of construction are as follows: The bed is wide, so that the head or tail stock do not overhang. The bed is supported by a three-point bearing, the support under the tailstock end being a swivel support. The headstock is wide, and a support on the rear connects the front and rear bearings of the upper spindle. The base of the headstock has a flat bearing on the ways of the bed and is arranged so that it can be adjusted slightly in order to properly line up the spindle should the lathe bore tapering at any time. The boxes are of bronze and the thrust of the spindle is taken on hardened tool steel washers. The lower spindle has a 2⅛" hole while the upper one is solid. Both are of high-grade hammered steel. The

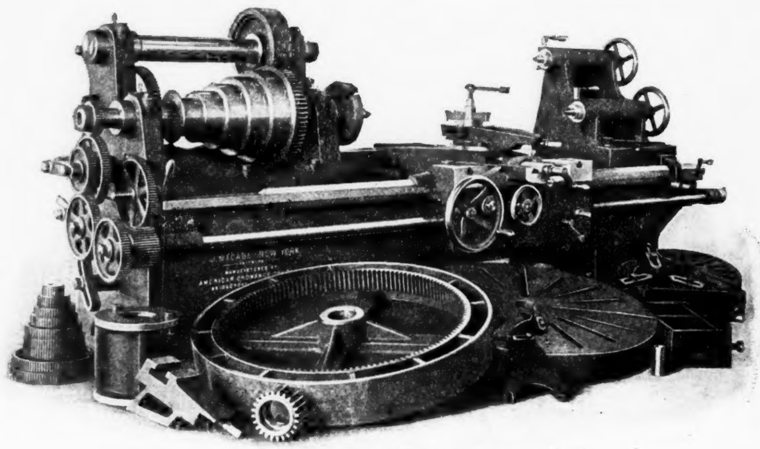


Fig. 2. The McCabe Lathe.

cone has five steps and is driven by a 3½" belt. The carriage is gibbed front and back, is 12" wide at the central part and has a bearing of 48" on the ways. The top is arranged with T-slots, for clamping large pieces for boring. The lathe has a compound rest on a cross slide 24" long and 12" wide. When using the upper spindle a blocking piece brings the tool to the necessary height. The arrangement of the feeds is after approved ideas in lathe construction and the screw cutting range is very large.

WORM MILLING MACHINE.

The Cleveland Machine Screw Company, Cleveland, O., have perfected the worm milling machine shown on page 231, so as to greatly reduce the cost of making worms, and to produce accurate ones in pitch, depth of cut and finish. In this machine the worms are milled instead of being cut in the ordinary manner, and they can be produced five to eight times faster than they can be cut in the lathe. Worms of any pitch, with single, double and quadruple threads, either right- or left-hand, may be milled. It does not require a skilled operator for the machine, and one man can attend to four or five.

The cutter holder is mounted on a slide that travels forward and back on ways, driven by a coarse-pitched screw. The cutter and worm are always held in proper relation, making it impossible to lose the thread, should the cutter be drawn out of the work, unless the adjustment is deliberately changed. The cutter spindle is back geared, and ball joints are provided so the cutter may be set to the angle of the worm thread. In cutting a worm, the cutter is set to the proper depth by a micrometer adjustment, and to the proper angle by the segment of a ring graduated in degrees. The cutter and worm blank both rotate at the correct speeds relative to one another, and any desired length of thread can be

cut. A continuous stream of oil floods the cutting edge, washing the chips into the bed inside of the machine.

In cutting a single-thread worm, the cutter advances through the blank once (or if desired, two cuts may be taken, one roughing and one finishing), completing the worm, the machine stopping automatically. When cutting a double-thread worm, after the cutter is through the first thread the

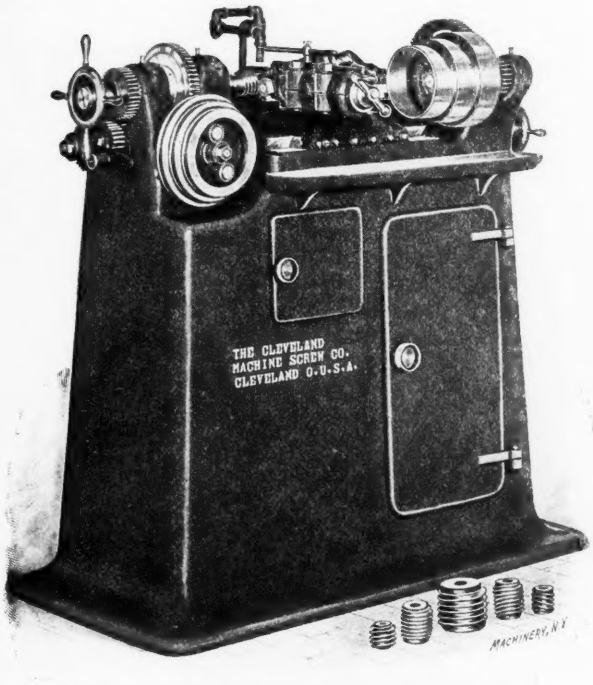


Fig. 3. Automatic Worm Milling Machine.

machine stops automatically and the cutter is drawn out of thread. It is but the work of a few seconds to adjust the machine for the second thread. The movements are identical for triple, quadruple, etc., threads.

The machine is so arranged that it will cut any even or uneven number of threads per inch without compounding the change gear in any case. Worms in size from 1" to 4" in diameter and all lengths up to 6" can be produced.

GANG DRILL.

The 6-spindle gang drill illustrated in Fig. 4 is designed for drilling locomotive frames, but it is serviceable for other work. The large table has upon its face, as well as upon its top, T-slots, for the purpose of bolting work of different shapes to it. The heads are movable transversely upon arms which have a lateral movement on the cross rail, and have about 12" overhang from the face of the table, when they are at their extreme outermost position. The spindles are counterbalanced and have independent vertical adjustment for varying length of drills. They are driven by gearing from the top shaft and controlled by clutches actuated by handles that are within reach of the operator. The spindles have hand power feed, quick approach and return movements, and an automatic stop motion. Spindles can be independently rotated or fed, stopped or started. Three changes of feed are provided. The table is T-slotted, and has an oil channel around the edge. Two countershafts accompany the machine. The dimensions are: Traverse of spindle, 12"; greatest distance, center to center, of outside spindles, 10'; minimum distance between spindles, 12"; adjustment of heads on arms, 7"; diameters of spindles, 3⅜"; distance between housings, 11' 4". This drill is manufactured by the Prentice Bros. Co., Worcester, Mass.

ELECTRIC HOIST.

The electric hoist in Fig. 5, combined with a trolley to run on the lower flange of an I-beam, is built in 3 and 5 ton capacities, the hoisting speed being at 15 feet a minute for the 5-ton, and about 25 feet a minute for the 3-ton. The illustration is of the 5-ton size, with a 7 horse-power motor of the enclosed type. The controller is of the drum type, and is the result of experimenting with a number of styles with a view to its operation by unskilled labor. The controller is brought to a central position automatically when the hand cords are released. The hoist is provided with a mechanical

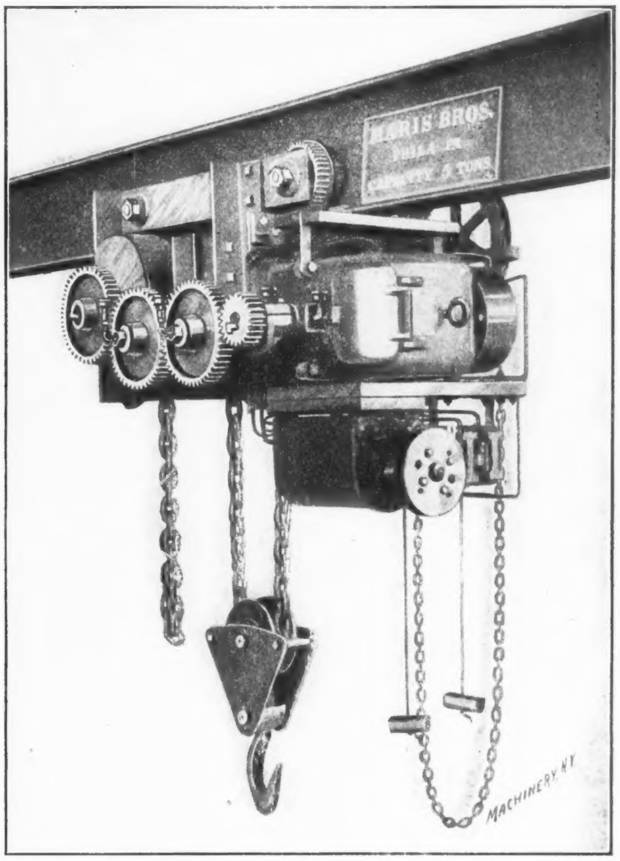


Fig. 5. Electric Hoist and Trolley.

brake for holding the load and an electric brake for promptly stopping the armature, both of these being automatic. The sprocket and sheave are provided with roller bearings, and grease cups are furnished on all bearings. The trolley wheels have roller bearings and motion by means of a hand chain from the floor. They can be made to be driven by a motor when desired, or for light loads the motor drive can be omitted

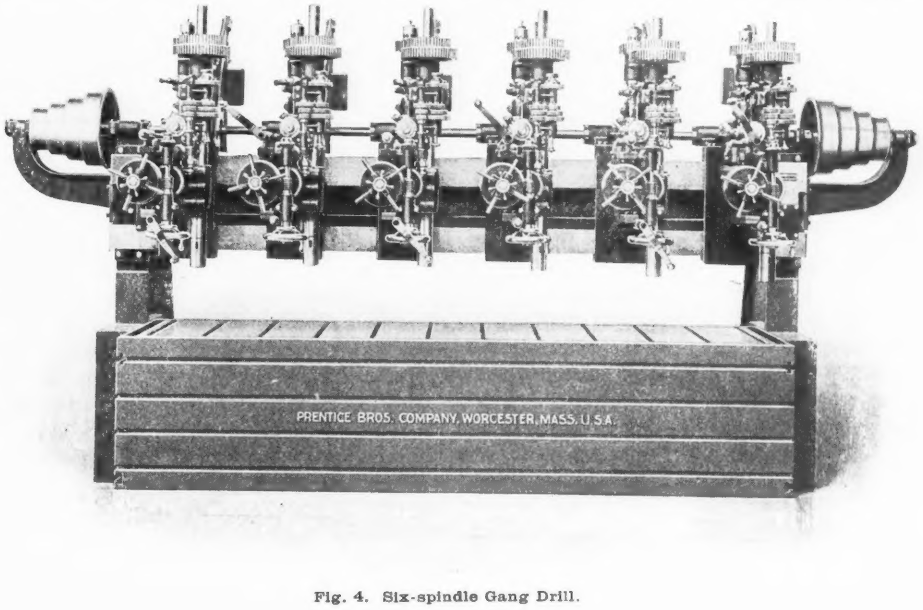


Fig. 4. Six-spindle Gang Drill.

and the trolley moved by pushing against the load. It is built by Maris Brothers, Philadelphia.

NEW BECKER-BRAINARD MILLING MACHINE.

A new horizontal milling machine has been brought out by the Becker-Brainard Milling Machine Co., Hyde Park, Mass., in which improvements have been made, especially in the direction of a machine with unusual capacity for a wide range of work. Attention is called to the length of saddle, which is equal to the full length of table and 10 inches longer than the maximum feed of the platen. The cross feed is also much greater than found on ordinary milling machines.

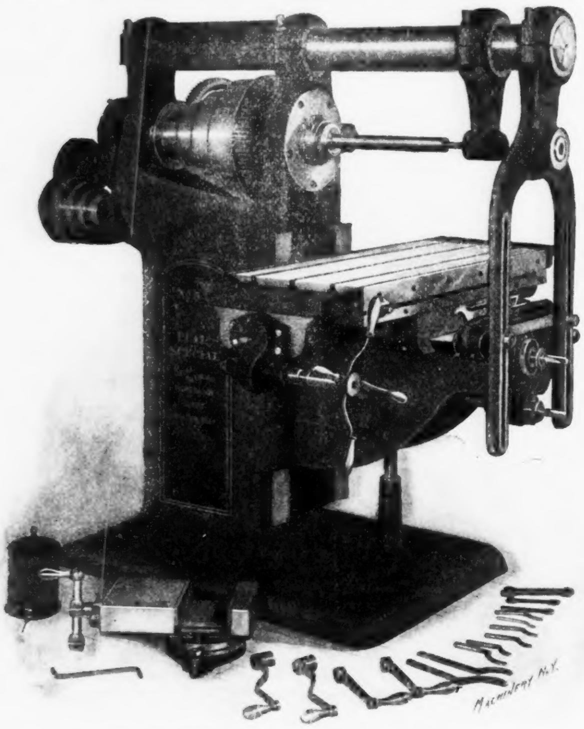


Fig. 6. Horizontal Milling Machine.

All table feeds are automatic in either direction and instantly reversible, and have automatic stops. The table feeds can be manipulated by hand from the front of the machine or at either end of the table, to suit the convenience of the operator. A quick return motion, in the ratio of 3 to 1, is conveniently located at the front of the machine. All feed screws have micrometer dials reading to one-thousandth of an inch. The knee may be fed automatically in either direction. The feeds are through a nest of gears in the feed box appearing in the second view.

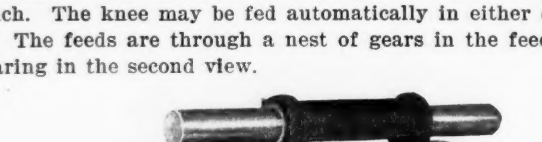


Fig. 7, Vertical Milling Attachment.

As shown in Fig. 7, this machine is provided with a powerful vertical spindle and angular attachment, the spindle being of such proportions that all cutters fitted to the hole of the main spindle can be used in the vertical spindle. The head can be set to any angle, and is well adapted for rack and slot cutting in line with the spindle. The rack cutter is run on an auxiliary spindle connected with the angular attachment, and is set to run between the bearings central with the axis of the vertical spindle. The unusual range of the cross feed permits end milling with the vertical spindle set in a horizontal position at a right angle with the main spindle.

There is also a rotary attachment provided with a graduated table, which is fed automatically in either direction and has 32 changes of rotary feed.

The following are the specifications of the machine:

Working surface of table, 16" x 48"; longitudinal feed, 42"; transverse feed, 16"; feeds per revolution of cutter, .003" to .350"; greatest distance between center of spindle and platen, 26"; diameter of spindle at main bearing, 3"; diameter of rotary table, inside, 19"; size of hole in spindle, B. & S. taper, No. 11. A four-inch belt is used.

MASSACHUSETTS TOOL COMPANY'S PRECISION LATHE.

The precision lathe shown in the accompanying cut is an interesting example of a well-made machine, so designed and built that it can be sold at a very low price and yet combine the elements that must enter into a practical precision lathe. The frame and head stock are cast in one piece, and are nicely japanned, as are also the tail stock, tool rest and countershaft.

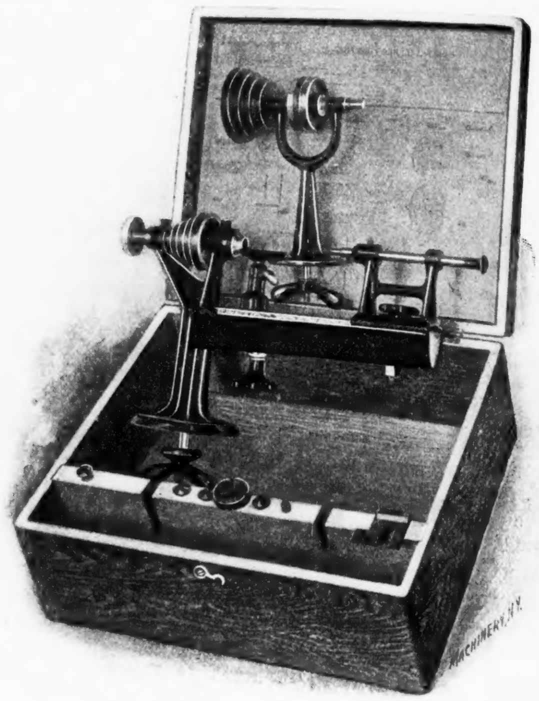


Fig. 8. Small Bench Lathe.

The lathe has a 12" bed, and swings 5" on centers. It is fitted with a hollow spindle, having a taper mouth and draw-in spindle for split chucks. The cone has four steps for a round belt. Four round wire split chucks, one step chuck, one saw arbor and one table rest are furnished with the lathe. It is furnished complete in the handsome polished hardwood case shown in the illustration. A compound slide rest, milling attachment, boring attachment and a sawing or filing attachment are furnished to order. The lathe and attachments are made and sold by the Massachusetts Tool Company, Greenfield, Mass.

UNIVERSAL MILLING MACHINE.

The Hendey Machine Co., Torrington, Conn., builders of the Hendey-Norton lathe, have brought out a universal milling machine, shown in Fig. 9, on the next page. It embodies a number of improvements and new ideas, notably in the way of attainability of feeds, general simplicity of parts, and durability of construction. In the device for changing the feeds, the Norton system of mounted gearing that is used on the Hendey-Norton lathe has been employed. Six changes in the gear box coupled with three settings of sliding gears mounted at the back of the machine, and taking the place of the usual cone pulleys, give a range of 18 feeds, from .003" to .160" per revolution, all obtained quickly and easily without the necessity of removing or substituting feed pulleys, gears, etc. The location of the gear box is at the side of the column, and appears in the illustration.

The construction of the spindle and bearings is generally the same as in the improved head stock of the smaller sizes of Hendey-Norton lathes. The bearings are taper, self-oiling

and self-adjusting, running in phosphor-bronze journals, capable of prolonged use without perceptible wear or need of alteration; in all, thoroughly adapted to maintain the alignment of spindle.

The upper housings carrying the overhanging arm are solid, the arm fitting the sleeves and clamping being effected by suitably shaped bushings locked against the arm by means of the binding handles shown in the cut.

The elevating screw for the knee is made telescopic and is fitted with a ball-thrust bearing. All feeds—longitudinal, transverse and vertical—are automatic in either direction; can be reversed while the machine is in motion, and are suitably provided with stops. These stops all have micrometer adjustment, affording minute adjustments. The feeds can be operated either singly or simultaneously. Binding handles are provided at necessary points, superseding clamps with wrenches.

The swivel carriage is graduated, and the table can be operated at any angle up to 45 degrees with the spindle.

The spiral head and centers swing 10" and take 19" in length. The head can be set at any angle from 15 degrees below the horizontal, through an arc of 210 degrees, to 15 degrees below the horizontal in the opposite direction. Its spindle is fitted with a dial suitably graduated for rapid indexing, and for this purpose the worm shaft can be dropped out of mesh. The device for binding the spindle tends to draw it back into its taper bearings.

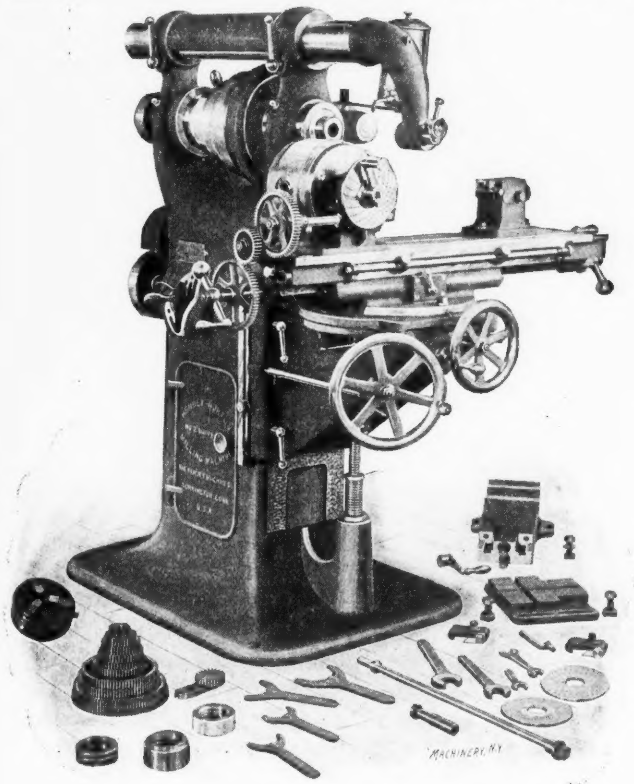


Fig. 9. Hendey-Norton Universal Milling Machine.

The main dimensions are: Taper hole in end of spindle, B. & S. No. 10; straight hole through spindle, 1 1-16"; diameter of nose and pitch of thread, 2½" x 4 per in. L. H.; four-step cone for 2¾" belt; distance from center of spindle to overhanging arm, 6"; distance from end of spindle to center in arm, 15". Dimensions of table, working surface, 37" x 8½"; longitudinal, lateral and vertical feeds, 23½" x 6½" x 17".

NEW VERTICAL MILLING MACHINE.

Blake & Johnson, Waterbury, Conn., have brought out a new vertical spindle milling machine, with rotary attachments, a view of which is shown in Fig. 10. It is back-geared, 5 to 1, and, with two speeds of the countershaft, has a wide range of speed. Ball thrust bearings are provided at the top and bottom of the main box to reduce the friction. The driving pulley of the spindle is 16" in diameter, 3-34" face. The back gears are independently mounted in an adjustable bearing, to relieve the spindle of all belt strain. The head has a vertical movement of 7½", and can be stopped at any point automatically. A micrometer gage, graduated to read to thousandths, is attached to the head and is adjustable to any height necessary. The table is 48" x 13", with automatic screw feed 42" in either direction, and also automatic screw cross feed of 14" in either direction. The slots in the table and also the top of the table can be milled off in the machine.

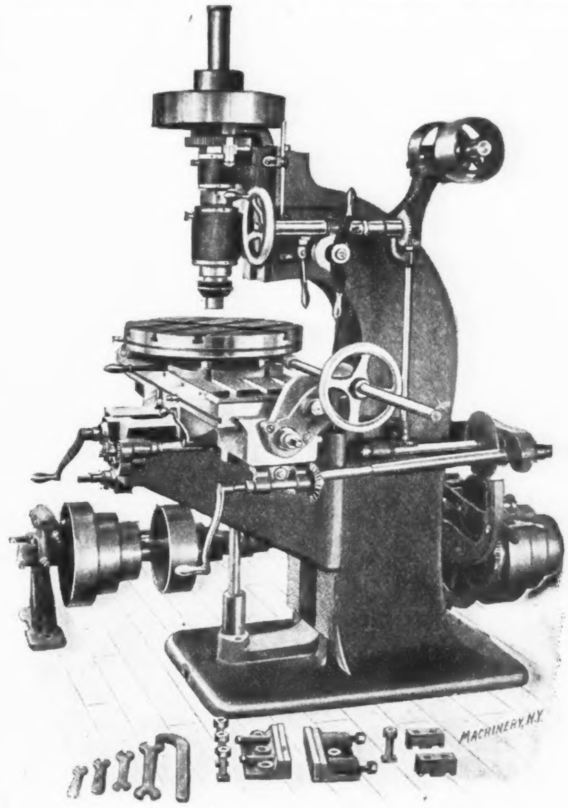


Fig. 10. New Size Vertical Milling Machine.

Another feature is the graduated index on the longitudinal feed, cross feed, and elevating screws. The feeds of the table are driven by cone pulleys and belts, and give eight changes of feed for each change of spindle speed. The knee has a vertical adjustment of 20". The greatest distance between end of spindle and working table is 22". The vise is made to fit T-slots in table; the jaws are steel faced, 9" x 2", and their capacity is limited only by the capacity of the table. The rotary attachment has a circular table 22" diameter, and is rotated automatically in either direction, and provided with automatic stop.

WET GRINDER FOR TWIST DRILLS.

The new wet grinder, illustrated on the following page, Fig. 11, has for its foundation the regular style of drill grinder made by L. S. Heald & Son, Barre, Mass., with the improvements illustrated in the February number of the paper. In addition, there is a water supply for wet grinding, and the emery wheel is provided with ample water guards to keep the water where it belongs and not allow it to be thrown over the floor and operator. The water is delivered to the wheel just where the work is being done, and in this way the full benefit is obtained from it, since there is no opportunity for any to be thrown off by centrifugal force before reaching the drill.

There is a large water pan mounted close up under the work, and it extends out far enough to be under the drill holder in all positions. From this pan the water drains into a reservoir, in which there are two compartments, one for a settling chamber and the other containing clear water, in which the centrifugal pump which furnishes the water supply is submerged.

The centrifugal pump is always submerged, and hence is always primed. It is mounted on a vertical axis, and the bearings are above the water and can easily be lubricated. This construction also requires no stuffing box, which is always a source of trouble, owing to the tendency of the water

to work out through it, and when this water contains grit from the emery wheel the packing becomes leaky and the bearings cut.

The pump is driven by a round belt from the countershaft, as will be seen in the engraving. The supply of water may be regulated by the valve shown in the angle of the pipe, and

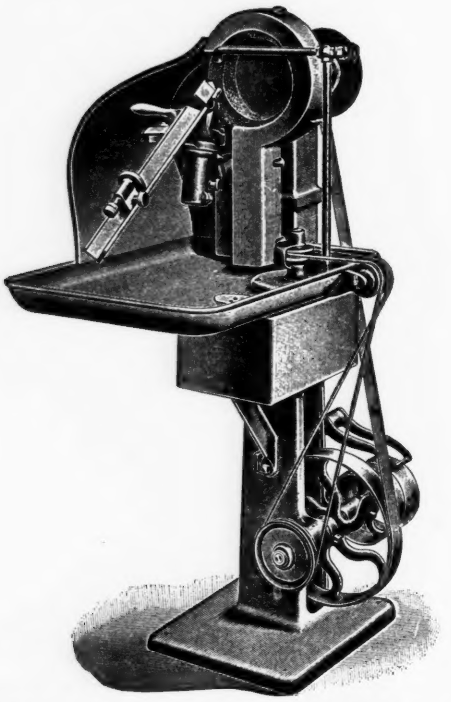


Fig. 11. Twist Drill Grinder with Water Attachment.

may be shut off entirely when desired. It is found very advantageous to use water when grinding drills of large size, for in these cases there is usually a good deal of material to be ground off to obtain a new cutting edge, and there is far less danger of drawing the temper when grinding this off if the wheel is provided with an abundant supply of water.

ELECTRICALLY DRIVEN SHAPER.

The accompanying cut, Fig. 12, shows one of Gould & Eberhardt's extension-base shapers, with direct-connected electric motor. As will be noted from the illustration, the motor rests on a pan, and the switchboard is fastened to a bracket on the back of the machine, making the whole arrangement

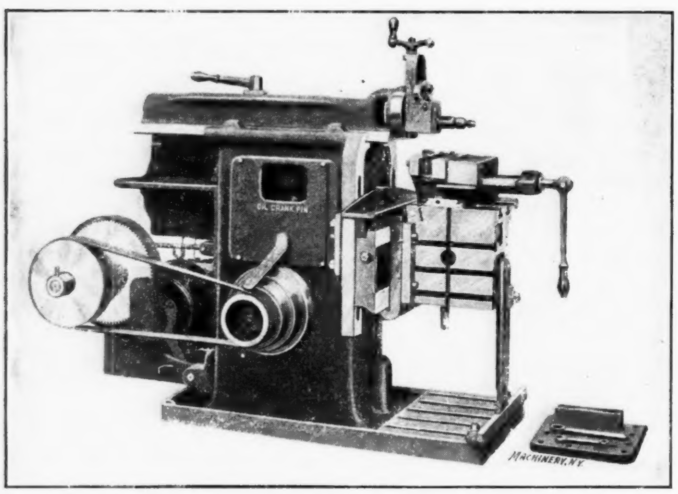


Fig. 12. Gould & Eberhardt Shaper.

self-contained. The switchboard and starting box were specially designed to operate under a 110 and 220 volt, three-wire, direct-current system, and has a double pole, double throw main-line knife switch.

On account of the shortness of the belt, and its consequent liability to slip under a heavy cut, there is provision for taking up the slack. The pan on which the motor rests is connected to the machine proper by a swinging joint, allowing an up-and-down adjustment to take up the slack in the belt. The adjustment is made by means of nuts on a threaded stud which projects from the machine over to the top of the motor, and holds the motor firmly in position. The machine is one of the third lot of shapers ordered from this firm for the Mare Island Navy Yard, San Francisco.

GANG PLANER TOOL.

The Armstrong gang planer tool, made by the Armstrong Bros. Co., Chicago, Ill., is illustrated in Fig. 13. This has recently been brought out and is adapted for surfacing large castings, the nature of the cut that it will take being illustrated in the same figure. The head of the tool is secured to the shank, on which it swivels to a limited extent, by means

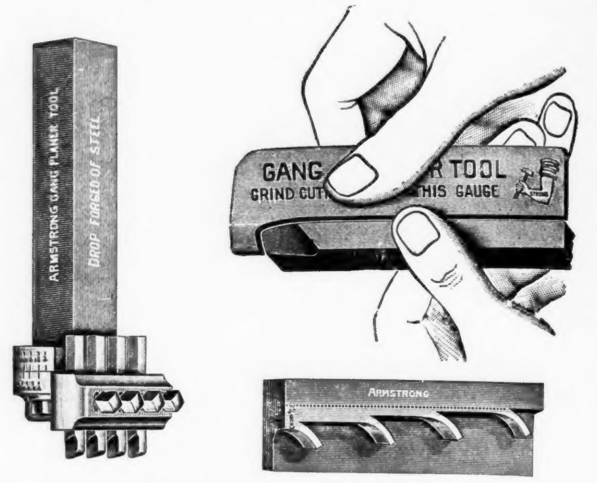


Fig. 13. Gang Planer Tool and Gage.

of a closely fitted tongue and socket, and when set it is clamped by two collar screws. Both shank and head are of drop-forged steel, all parts are hardened, and the head is graduated. Since each of the chips carried by the tools is comparatively light even when taking a heavy cut, a feed and depth of cut can be taken not possible with a single tool. The cutters are made from stock sizes and shapes of self-hardening steel. One of the greatest difficulties with a tool of this description has been the grinding of cutters to a uniform shape. A gage is provided, however, which overcomes this objection, and to line up the cutters to a uniform depth it is only necessary to let them rest on a flat surface while tightening the set-screws.

* * *

The issue of *Steam Engineering* for February 15 contains the first paper of a series by Chas. L. Hubbard on "Power and Heat for Office Buildings," illustrated by excellent engravings of various boiler settings. There are three educational articles for engineers, treating of the various problems that properly belong to the present field of the stationary engineer. An interesting article, "Crank-Pin Designs," by the well-known writer, "M. E.," graphically illustrates the weakness of various designs and gives twenty-three diagrams showing several forms of crank-pins seldom seen in American design. The Grisson cam-transmitting device, by which great reductions of velocity ratio are accomplished with an efficiency of little less than 100 per cent, is described, and illustrated with two engravings. As usual, the letters from correspondents and the answers to inquirers form two of the most valuable departments for the practical engineer and the machinist interested in the development of steam engineering.

* * *

George H. Boyd and Thomas D. West, Sharpsville, Pa., have patented a method for strengthening the teeth of large cast gears. It consists of casting flat metal plates in the teeth, the plates extending from the rim of the wheel into the teeth. These plates are prepared by a process which causes the iron to firmly adhere to them and are placed in the mold before casting the gear. It is said that apart from strengthening the teeth the effect of the plates is to chill the teeth internally, and to give them soft faces, which is just the reverse of the usual condition, allowing the teeth of two gears to wear themselves into contact very quickly.

DUST-PROOF OIL CUPS.

The Bowen Manufacturing Company, Auburn, N. Y., have brought out a new line of oil cups for automobiles, motors and machinery of all kinds. The feature of all these cups is that they are self-closing and that when opened, clean surfaces are presented so that grit and dirt are not introduced to the journal with the oil.

For automobiles it is desirable to have a cup that can be readily opened at arm's length with the spout of the oil can and it is also highly desirable that oil cups for these machines be absolutely dust and dirt proof. Style A is made to fill these conditions and is made in a variety of sizes all with hexagon sides at the base so as to be screwed in place with an ordinary wrench.

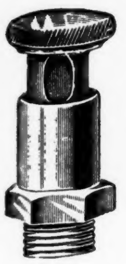


Fig. 1.

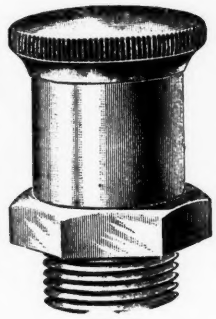


Fig. 2.

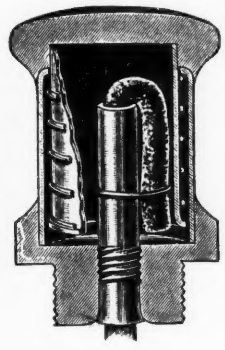


Fig. 3.

The cup shown in the accompanying cuts is style B made in eight sizes. The cuts, Figs. 1 and 2, show it in the open and closed positions. Fig. 3 gives the internal construction, showing the inner tube and wick. The cover is held down by the coil spring around the internal barrel, and it can be shifted around to any position so that the side filling hole will be convenient. When the cover is down, it closely fits the fillet at the top which effectually prevents the ingress of foreign substances.

* * *

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

24. A. L. K.: Give a recipe for a non-corrosive soldering fluid.

A.—A soldering fluid or flux which is non-corrosive is made by mixing one pint of grain alcohol with two teaspoonfuls of chloride of zinc, or proportional amounts of each. Chloride of zinc is the combination resulting from dissolving zinc in muriatic (hydrochloric) acid, making the ordinary tinners' soldering fluid, but when so prepared there is always present a certain amount of uncombined acid which attacks the piece soldered. The chloride of zinc used with the alcohol, being free from acid, does not perceptibly affect the work. Thoroughly mix before using.

Answered by Wm. Baxter, Jr.

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25. S. D.: I wish to set up a three-candle power incandescent lamp. Would you be so kind as to tell me how to charge a battery so that it will feed the lamp for ten hours each night at a small cost? I am told that Edison, Jr., has perfected a lamp that will maintain a light for ten hours for two cents.

A.—If Edison, Jr., has perfected such a lamp as you mention, he will probably be able to purchase the N. Y. Central in a few months. Such a lamp cannot be made unless the light is about as strong as that of a firefly. To keep a three-candle power lamp running will require about two-hundredths of a horse power counting in the losses; and this amount of energy, if obtained with the most economical type of primary battery, would cost about half a cent per hour, under the most favorable conditions. It would probably cost you one cent per hour. The wisest course for you to pursue is to go to a reliable electrical supply store and tell them what you want and they will furnish the most desirable form of battery for the purpose. Our impression is that the Gordon battery would be the best suited to your case. Gravity batteries are also good, but more of them would be required, and if not properly set up and charged they might give you trouble. Dry batteries are of no value for this class of work.

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26. L. C.: Two 110-volt shunt wound dynamos are run on a three-wire system. If it is desired to increase the capacity of the plant by adding a 220-volt machine, should the latter be compound wound? How should it be started?

A.—If the machines now in use are shunt wound, the new generator should be of the same type, as it is difficult to run compound and shunt wound machines together. Arrangements of this kind do not, as a rule, give very good results because the 220-volt machine is not likely to change its voltage with increasing current in the same ratio as the other generators. If the three machines are from the same maker, they will probably run well, especially if it is understood that they are to run connected in the same system. In starting you can connect the 220-volt machine first, or the other two. If the high voltage machine is started first, care must be taken when the second of the other two is connected, that its voltage is equal to the difference between the first machine and the new one. No special care need be taken in connecting the first of the low-voltage machines, for when this machine straddles one side of the system, and the new one is connected across the outside wires, the first named one will act as a generator if the current required for its side of the current is the strongest; and it will run as a motor if its side takes the smallest current. When all the machines are running, the two low-voltage generators should be regulated to the same *e. m. f.;* if not one side of the circuit will have a higher voltage than the other.

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27. J. A. T.: I would like some information about gear cutting. We are making gears with 120 teeth, 22 pitch, which run at 1,200 revolutions per minute. The wheel is made of steel, and a brass pinion having 18 teeth meshes into it. Running at the speed named, we cannot make them all run noiselessly; some run very quietly, but others do not. Would you advise using a lubricant in cutting the brass pinions, and if so, what kind? We use B. & S. cutters 2¼ inches diameter. What speed and feed would be the best? Would it be best to cut the teeth in succession or every alternate one and finish the others on the second round?

A.—If the wheel runs at 1,200 revolutions per minute, the pinion will have a velocity of 8,000 turns, which is very high. At this enormous speed we think you do well to make any of the gears run quietly, and very likely are making them about as true as they can be made. Cutting the alternate teeth may increase the accuracy of the pinion, on account of the teeth being narrow at the point, and therefore liable to be sprung over by the cutter, but it is doubtful whether the difference will be noticeable. The use of lubricants with the brass pinions we believe would not be advisable. The best results can be obtained with brass, by keeping the cutter very sharp, and being sure that it is ground square, so that one side may not have more of a tendency than the other to hook in. With both wheels, the final cut should be light, using a very sharp cutter, and the feed should be rather slow. The speed for the large wheel should be moderate, but for the brass pinion greater accuracy will be attained at a high speed.

Answered by Geo. L. Fowler.

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28. G. G.: 1. Kindly explain the method of producing so-called mottling such as is seen on small surface gages and other small tools. 2. How can a steel template of a true ellipse be made?

A. 1. The frosting on metal work consists merely in scratching a highly polished surface. The scratches themselves must, however, be fine, close together and irregular in direction. The method of accomplishing this result is to first put the polish on the metal. Then take flour of emery and oil and rub the surface with this, by applying on a pine stick. The movement of the stick may be irregular or in curved lines, but not parallel to the direction of movement by which the original polish was obtained. If the metal has not been brought up to a high state of polish a coarser grade of emery, applied with a hardwood stick, may be used. Finally a rougher frosting can be produced by the use of an ordinary whetstone. 2. The steel plate from which the template is to be cut should be made smooth and straight on one surface. This surface should then be coated with a very thin film of beeswax. To do this the plate should be warmed and the wax

made quite hot. The addition of a little tallow will prevent a too rapid cooling of the wax. On this waxed surface the ellipse should be drawn by any of the methods used for such work. Cut the outline through the wax to the metal, making the line of exposure of the metal as fine as the point of a cambric needle. Apply diluted sulphuric acid to the surface for a minute or so, and then wash off with water. Heat the plate gently and evenly to remove the wax and the outline of the ellipse will be found etched on the surface. It then merely remains to work the metal down to the line that has been drawn upon it.

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ADVERTISING LITERATURE.

Sawyer Tool Co., Fitchburg, Mass. Catalogue D of machinists' tools such as scales, bevel protractors, surface gages, inside micrometers, hammers, calipers, etc.

The George Gorton Machine Co., Racine, Wis. Illustrated circular of the No. 4 disc universal flat surface grinder. The details of construction of this grinder are shown by both line drawings and half-tone illustrations.

Fay & Scott, Dexter, Me. Illustrated circular of several forms of turrets and combination tool posts for use on the ordinary engine lathe. They are designed for the rapid production of every-day work.

Clayton Air Compressor Works, 26 Cortlandt Street, New York. Catalogue of air compressors of all types, for high and low pressure, and also carbonic acid gas compressors, vacuum pumps, compressed air tools and appliances.

Cling-Surface Mfg. Co., Buffalo, N. Y. Attractive circulars calling attention to the merits of Cling-Surface, with illustrations from photographs showing numerous belts running with one side slack while transmitting power.

Wyman & Gordon, Worcester, Mass. A leaflet which is one of a series containing a short article on some interesting subject, and incidentally calling attention to their drop forgings. Wireless telegraphy is mentioned this month.

The Goodell-Pratt Co., Greenfield, Mass. Catalogue of small tools for both machinists' and woodworkers' use. These tools include several forms of screw drivers and hand and breast drills, bench drills, drill chucks, hacksaws, etc. A power hacksaw is illustrated and also several sizes of grinding and polishing heads.

American Blower Co., Detroit, Mich. Illustrated sectional catalogue No. 118 entitled the "A. B. C. System of Mechanical Draft." This catalogue considers forced and induced draft by blowers and exhaust fans. There are numerous excellent half-tone illustrations showing applications of the system, and there are tables and directions relating to the subject, making the catalogue a text book upon forced draft.

The Gleason Tool Co., Rochester, N. Y. Illustrated catalogue of gear planers ranging from 12- to 144-inch sizes. This is the most artistic and attractive catalogue that has been recently received, and is quite unusual both because of its arrangement and of the clearness of the illustrations and typography. It will prove of interest to any one who are interested in the subject of accurate bevel gears.

The Northern Engineering Works, crane builders, Detroit, Mich. Catalogues of air hoists and pneumatic hoisting appliances, intended as a supplement to their crane catalogue. It is of 16 pages and cover, 6" x 9", numbered 32, and contains descriptions of the various types of pneumatic hoists and cranes made by this company. Dimension tables and diagrams showing air consumed, etc., are given in detail.

W. P. Davis Machine Company, Rochester, N. Y. Illustrated catalogue of lathes, drills, keyseaters, cutting-off machines and special machinery. The cover is handsomely embossed with a cut of their 32" engine lathe, a tool designed for heavy and accurate manufacturing work. The catalogue as a whole is very tastefully gotten up and is a credit to the manufacturer whose tools are listed in it and also to the engravers and printers responsible for its typographical excellence.

Buffalo Forge Co., Buffalo, N. Y. Series of four folders on mechanical induced draft, forced draft, down draft forges and high-speed engines. These folders are gotten up in convenient shape to slip into an ordinary envelope, being intended for widespread distribution, profusely illustrated with cuts of the great variety of appliances and apparatus made by this company, which, in most instances, are very briefly described on the same page.

MANUFACTURERS' NOTES.

The Burt Mfg. Co., Akron, O., recently received an order for two 150-gallon Cross oil filters to equip the new modern power house of the Havana Street Ry. Co., Havana, Cuba.

The Waterbury Tool Co., Waterbury, Conn., manufacturers of ratchet drills, have moved to 63 Grand St., and added new machinery.

We are informed that Mr. George F. Faber, who was for seven years with Warner & Swasey, Cleveland, O., has been appointed office manager for Bardons & Oliver, also of Cleveland.

The Garry Iron & Steel Roofing Co., Cleveland, O., report that they have just shipped one of their pneumatic cranes to the New York Central Railroad, the fourth pneumatic crane of this type which the railroad has in use.

J. H. Williams & Co., Brooklyn, write us that they have voluntarily arranged with their employees that their factory shall be run on the basis of a nine-hour working day, commencing with March 1st. The wages of the employees are to remain the same as for the ten-hour day.

We are informed that Hill, Clarke & Co., Boston, Mass., have opened an office at 253 Broadway, Room 205, New York, and that Mr. E. D'Amour, of the firm of D'Amour & Littledale, will be in charge. They add that they have several new machines which they are putting on the market.

Loring Coes & Co., Worcester, Mass., write us that they have registered two trade marks for machine knives. The first consists of the words Micro-Ground being number 35873, and the second consists of the same words surrounding an eagle. This is numbered 35874. Both were issued Feb. 5, 1901.

The Arthur Co., 188-190 Front Street, New York, report a bright outlook for 1901, especially in their gear department, where they have added two 7-foot spur gear cutters and one 6-foot spiral gear and worm cutting machine of their own design. They are also putting in one of the latest 84" boring and turning mills, for machining large gear blanks.

We have been informed by the Walworth Mfg. Co., Boston, Mass., that the price of Stillson wrenches has been very materially reduced and that new prices can be obtained from all jobbers carrying the goods, or from the Walworth Mfg. Co. This wrench, we are told, is made of tool steel throughout, no portion of it whatever being of low-quality steel, therby making it a very durable and reliable wrench.

The Nicholson File Co., Providence, R. I., have acquired the business and factories of the Arcade File Co., Anderson, Ind., and rumor has it that another large file-making concern will soon be taken into the combination. The addition of these two plants will easily make the Nicholson company the largest file manufacturers in the world, as they will have a capacity of 9,500 dozen files and rasps per day, and will give employment to nearly 2,300 men. The main offices of the new company will be at Providence, R. I., where all mail should be addressed.

Beaman & Smith, Providence, R. I., have completed one of their large horizontal boring and drilling machines having a vertical movement of the spindle 7 feet and a horizontal movement of 9 feet, for the new Navy Yard shops at Brooklyn, N. Y. They have also under way numerous machines of special and regular pattern, including a duplex pump boring machine, a machine for facing the ends of the cradles for large duplex pumps, a special boring machine for triplex cylinders and another horizontal boring and drilling machine similar to the one that is to be shipped to Brooklyn.

The Philadelphia Pneumatic Tool Co., Philadelphia, Pa., report a large increase in business for the month over the preceding months. Duplicate orders have been received from some of the largest manufacturers in this country for their pneumatic hammers and they report a large number of orders for their long stroke riveting hammers. They are making arrangements to further increase their capacity and will, in the near future, be able to fill all orders promptly. Mr. Robert T. Mickle, M. E., formerly with the Kensington Engine Works, Ltd., has been elected vice-president of the company.

Scranton & Co., 42 Church St., New Haven, Conn., have recently added considerably to their facilities used in the manufacture of the Scranton Upright Power Hammer, and have also added a number of improvements to this power hammer, which will be of advantage to those interested in the forging of metal into such shapes as require a power hammer. They inform us that their sales last year for this machine were notably satisfactory and they consider the prospect for 1901 exceptionably promising. They will gladly give full information to parties thinking of adding a power hammer to their works this spring.

The Cleveland Punch and Shear Works Co., Cleveland, O., announce that they put their new battery of boilers in operation January 17, and will soon have their new engine installed and running. With modern electrical equipment throughout their shops, they say they expect to have one of the most complete plants in the country for the production of heavy tools. They have recently received an order from the Government for a heavy punch for the Mare Island Navy Yard; for a 72" multiple punch for the Ohio Cultivator Co., Bellevue, O., and eight punches for the American Car and Foundry Co., Detroit.

The Bullock Electric Mfg. Co., Cincinnati, O., report a large number of sales for the week ending Feb. 2. Among them were Joseph Joseph, Cincinnati, O., one 50 K. W. engine type; Manning, Maxwell & Moore, New York, one 180 K. W. engine